PSYCHOLOGICAL FOUNDATIONS OF MUSICAL BEHAVIOR

FOURTH EDITION

By

RUDOLF E. RADOCY
J. DAVID BOYLE

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In this exceptional new fourth edition, the authors have elected to continue a "one volume" coverage of a broad array of topics, guided by three criteria: The text is *comprehensive* in its coverage of diverse areas comprising music psychology; it is *comprehensible* to the reader; and it is *contemporary* in its inclusion of information gathered in recent years. Chapter organization recognizes the traditional and more contemporary domains, with special emphases on psychoacoustics, musical preference, learning, and the psychological foundations of rhythm, melody, and harmony. Following the introductory preview chapter, Chapter 2 examines diverse views of why people have music and considers music's functions for individuals, its social values, and its importance as a cultural phenomenon. Chapter 3 discusses "functional music" and music as a therapeutic tool. Chapter 4 discusses descriptions and relationships involving psychoacoustical phenomena and gives considerable attention to perception, judgment, measurement, and physical and psychophysical events. Chapter 5 examines rhythmic behaviors and what is involved in producing and responding to rhythms. Chapter 6 considers horizontal and vertical pitch organization, tonality, scales, and value judgments, as well as related pedagogical issues. Chapter 7 examines basic aspects of musical performance, improvisation, and composition. Chapter 8 discusses approaches to studying the affective response to music with particular emphasis on developments in psychological aesthetics. Chapter 9 examines existing musical preferences and tastes. Chapter 10 closely relates the development and prediction of musical ability, music learning as a form of human learning, and music abnormalities. Finally, in the tradition of prior editions, Chapter 11 speculates regarding future research directions. This unique book is intended especially for undergraduate and graduate students in music education, music therapy, psychology, and related fields, but it will also be of interest to musicians, educators, therapists, business people, and anyone with a serious interest in music's power.

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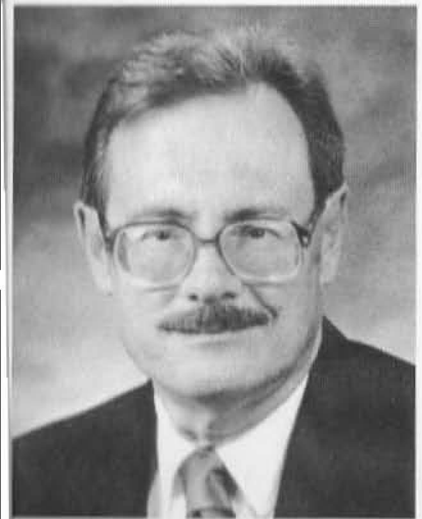

Rudolf E. Radocy taught psychology of music, musical acoustics, sociology of music, and other classes pertinent to music education and music therapy at the University of Kansas for 29 years; he taught music for five years in Michigan elementary and secondary schools. In addition to three prior editions of this text, he is the co-author of *Measurement and Evaluation of Musical Experiences.* A former editor of the *Journal of Research in Music Education* and contributor to various professional journals, Dr. Radocy holds degrees from the Ohio State University, the University of Michigan, and the Pennsylvania State University.

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Fourth Edition

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PREFACE TO THE FOURTH EDITION

The fourth edition of *Psychological Foundations of Musical Behavior* appears at a time of stress and turmoil in the world. The early twenty-first century is marked by acts of terrorism and war, cases of starvation and pestilence, financial chaos, uncertainty regarding climactic changes, and concern over how to care for an ever-expanding population with limited resources. Many problems regarding politics, religion, economics, and natural phenomena defy solution.

The twenty-first century also is a time of positive developments. Rapid international communication enables almost instantaneous attention to any part of the world. Evolving understanding of the human genome promises control and alleviation of genetic misfortunes. Diseases and physical challenges that once were almost a death sentence upon diagnosis are becoming amenable to various pharmacological, surgical, and therapeutic interventions. As in earlier times of worldwide turmoil and opportunity, humans may express, challenge, enhance, and/or negate surrounding conditions through the organization of sound and silence: *music.* Musical styles change; music's functions do not. A pleasant diversion, a profound aesthetic experience, a symbolization of a nationalistic or religious ideal, a personal journey through time, a sales tool–all are roles which music may fulfill.

We have learned a lot about human musical behavior. We have some understanding of how music can meet diverse human needs. Many individuals–psychologists, educators, therapists, music theorists, composers, performers, and others–have contributed to a vast array of knowledge, loosely organized into a psychology of music, or, perhaps more accurately, a psychology of musical *behavior.* The knowledge embodied in that psychology of musical behavior may help enhance individuals' musical abilities, sensitivities, and enjoyment.

Thus, a comprehensive examination and reexamination of the psychology of musical behavior seems particularly appropriate at this time. Understanding music cognition, representation of musical structures, and the traditional areas of psychoacoustics, music learning, cultural organization of musical patterns, measurement and prediction of musical ability, the affective response to music, and musical preference all merit renewed attention.

Much remains to be learned about human musical behavior. While this edition draws on published findings appearing since the third edition (1997)

reinterprets some older findings, it is far from any final "truth" regard-
how people create, perceive, organize, and employ musical sounds.
itably, new research will appear, and new questions will arise. Given the
emporary tendency to publicize research results with only partial under-
ding, some individuals will make premature conclusions regarding
c's roles in people's lives and how people process music. Further
rch and writing will be necessary to mitigate those conclusions.
s with all original textbooks and revisions thereof, constraints of time,
e, and resources necessarily limited this revision's scope and breadth.
authors have exercised their professional judgments, based on teaching
ses and conducting research and other scholarly inquiry, regarding con-
Naturally, some arbitrary decisions were necessary, and the book
cts the authors' scholarly biases.
ecent years have seen the appearance of various texts addressing spe-
zed areas within music psychology, especially cognitive perspectives.
represents an increasing diversification within the field. The authors
elected to continue a "one-volume" coverage of a broad array of top-
guided by the three "criterion c's": The text should be *comprehensive* in its
erage of diverse areas comprising music psychology, *comprehensible* to the
ler who is literate in English (or the language into which the text is trans-
d) and possesses some background in music and psychology, and *contem-
ry* in its inclusion of information gathered in recent years.
Again, while the world is everchanging, and music's uses change with it,
presence of music is unchanging. The authors offer their latest review of
ects of human musical behavior with profound recognition of music's
uring values.

R.E.R.
J.D.B.

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Many individuals contributed to the successful completion of this fourth edition. These include numerous students over the years in the authors' classes at The University of Kansas, The Pennsylvania State University, and The University of Miami, as well as students elsewhere using prior English, Japanese, and Korean editions. The authors are indebted to professional colleagues, especially Dr. William Hipp, Dean of the School of Music at The University of Miami. Particular assistance from Dr. Albert LeBlanc regarding musical preference and Dr. Wanda Lathom-Radocy regarding music therapy is acknowledged. While the authors have relied on knowledge and contacts made during many years of their university careers, they also have gained some perspective as they pursue their new careers, oceanic environmental observation (RER) and neveian frictional propulsion (JDB). Finally, the authors are grateful to their loving wives, Dr. Wanda B. Lathom-Radocy, and Dr. Arlene Boyle, for their continued loving support and encouragement.

R.E.R.
J.D.B.

CONTENTS

PSYCHOLOGICAL FOUNDATIONS OF MUSICAL BEHAVIOR

Chapter 1

INTRODUCTION

Purpose

This book reviews human musical behavior comprehensively, from a psychological perspective. Music has been a vital component of human culture since before recorded history. Human organization of sound for functional and aesthetic purposes raises many fascinating, although occasionally unanswerable, questions. Description, prediction, and explanation of musical composition, performance, and listening behaviors are continuous challenges. In recent years, claims regarding music's purported therapeutic, commercial, and educational benefits have increased, thanks in part to hasty interpretations of incomplete data. This book focuses questions and general interest on describing, predicting, and explaining human musical behavior and seeks to promote a healthy skepticism regarding premature conclusions about music's influences. Psychologists, musicians, educators, therapists, business people, and anyone with a serious interest in music's power may find it beneficial.

Understanding human musical behavior is useful for the performing musician, whether in the studio, on stage, in the classroom, or in a commercial setting. Why do people prefer certain sounds over others? How relevant is precise pitch discrimination? What psychoacoustical processes underlie musical perception? What cognitive processes turn a stream of perceived sonic events into music? Are some individuals naturally "musical" or "unmusical"? Why is a deviation from stereotyped performance practice a "stroke of creative genius" when done by a well-known conductor but "failure to understand the style" when done by an amateur? Does the master performer differ in some fundamental way from the struggling student, or is it just a matter of more practice? Knowledge of human musical behavior in diverse manifestations and situations is essential for addressing these and other numerous questions.

The person who wishes to sell products or services or enhance entertainment needs to consider various uses of music. Can business employ music in successful marketing strategies? Can impulsive shoppers be encouraged to linger longer and spend more as a function of musical background? Is the

nusic essential to an unfolding narrative?

Music's therapeutic functions are well documented, but therapy is not a :ure. In what settings is music useful as a healing agent? Are there instances vhere music may be harmful? Are there physiological changes underlying he behavioral changes noted with musical experience? The growth of the nusic therapy profession owes much to evolving understanding of human nusical behavior, and researchers investigating musical phenomena owe nuch to music therapists' documentation of their experiences.

Contemporary educators, struggling to balance conflicting philosophies nd societal demands, may find utility in developing understanding of and amiliarity with human musical behavior. Does music really motivate and/or edate students? Why are children more receptive to "different" music in the rimary grades than in later years? Does musical ability relate to intellectual r manual abilities? Again, although this book can not promise definitive nswers, the information provided may focus relevant inquiry.

Scope

Music psychology's traditional domains include psychoacoustics, measrement and prediction of musical ability, functional music, cultural organiation of musical patterns, music learning, and the affective response to nusic. Music cognition, broadly defined, has been a dominant domain for he past quarter of a century or so. Music's catalytic uses in business, educaonal, and therapeutic settings, while clearly within the traditional domain of nctional music, arguably comprise emerging contemporary domains. The hapter organization recognizes the traditional and more contemporary lomains, with special emphases on psychoacoustics, musical preference, earning, and the psychological foundations of rhythm, melody, and harmoy. The chapter on music as a phenomenon of people, society, and culture eflects contemporary interest in music's various roles as a catalyst for social ehavior and its diverse sociocultural functions. While music psychology nce gave less attention to performance and creative activity than to listeng and associated behaviors, performance, composition, and improvisation ow receive special attention.

Musical behavior is but one aspect of *human* behavior. Consequently, musil behavior must be subject to whatever genetic and environmental factors ifluence all human behavior. Throughout, the book expresses a concern for 'hat people *do* with musical stimuli and what musical stimuli *do* to them, in atural as well as laboratory settings.

Behavior, as used herein, means the observable activities of living dynam- human beings. Such activities are of interest either in themselves or as xternal evidence of some internal state. *Cognition*, the internal processes of

assimilating, organizing, remembering, and recalling information (or "thinking"), may be a covert behavior, but the only way to study covert behavior with relative objectivity is to study its overt manifestations. *Perception* is a process of sensing the environment; obviously, it is essential for much behavior. Perception may be studied only through evidence of its results. Musical behavior includes performance, listening, and creative activity involved in composition and improvisation. The study of musical behavior necessarily includes related cognitive and perceptual processes. That which people *do* with music is musical *behavior*. So, too, is that which music *does* to people.

As Gaston (1968, p. 7) indicates, musical behavior is studied through psychology, anthropology, and sociology. The book primarily reflects a psychological approach: Psychology is the study of human behavior. Nevertheless, the authors have looked beyond the general body of psychological literature. Sociology, anthropology, philosophy, music history, acoustics, and business are germane areas from which the authors have drawn material.

Preview

As with the three prior editions, the authors have considered the dynamic (in the sense of moving and everchanging) aspects of music performance and listening as well as important influences of prior experiences on present behaviors. No human musical activity results solely from willful interaction with music. Cultural influences, learning, and biological constraints are as crucial as motivation, reward, and any "inherent" properties of the musical stimulus. Gaston's (1957, p. 25) statement, from over two score years ago, remains significant:

> To each musical experience is brought the sum of an individual's attitudes, beliefs, prejudices, conditionings in terms of time and place in which he lived. To each response, also, he brings his own physiological needs, unique neurological and endocrinological systems with their distinctive attributes. He brings, in all of this, his total entity as a unique individual.[1]

Chapter 2 examines diverse views of why people have music and considers music's functions for individuals, its social values, and its importance as a cultural phenomenon. While the focus is largely on Western music, certain ethnological research suggests that commonalities of musical function exist across different cultures.

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[1]This is a direct quote of material written at a time when generic use of masculine terms in reference to unspecified individuals or humanity in its entirety was customary. In their original writing, the present authors have avoided exclusive reference to one gender when they discuss unspecified individuals or humanity in general.

Much of the world's music exists primarily to further some nonmusical or extramusical purpose, such as selling something, sedating or stimulating people, enhancing a story through film or television, or facilitating and enriching ceremonies and rituals. Chapter 3 discusses such "functional music." It also provides a basic discussion of music as a therapeutic tool.

Music would not exist if people were unable to perceive and process certain psychoacoustical phenomena, such as pitch, loudness, and timbre. Accordingly, Chapter 4 discusses basic descriptions and relationships involving psychoacoustical phenomena and gives considerable attention to perception, judgment, and measurement, as well as physical and psychophysical events.

Music is a time-based art form; some organization of the durations of sounds and silences is necessary in all music. Chapter 5 discusses rhythmic behaviors and what is involved in producing and responding to rhythms. The authors believe that rhythmic response is learned; no person "has rhythm" on an absolute inherent basis.

Definitions and opinions regarding melody and harmony differ; whether those properties exist in all music is debatable. Nevertheless, they are vital considerations of much Western music, and musicians and nonmusicians use the terms freely. Research in cognitive psychology suggests that the mental organization of music depends, in part, on structural aspects involving melody and harmony. Chapter 6 considers horizontal and vertical pitch organization, tonality, scales, and value judgments, as well as related pedagogical issues.

Chapter 7 examines basic aspects of musical performance, improvisation, and composition. It considers characteristics of the expert performer, performance anxiety, creative and *re*creative aspects of making new music, and related philosophical and pedagogical issues.

Chapter 8 is concerned with the "chills up the spine" effect and other indications of an affective response to music. Physiological changes may occur in experiencing music, but what is their nature? Are these affective? What is the influence of training and experience? What makes "beautiful" music "beautiful"? The chapter discusses several approaches to studying the affective response to music, with particular emphasis on developments in psychological aesthetics.

Musical preference is the subject of Chapter 9. It examines existing preferences and tastes and discusses musical and social variables of which musical preference is a function.

Chapter 10 closely relates the development and prediction of musical ability, music learning as a form of human learning, and musical abnormalities. Music as a form of human intelligence, diverse approaches to assessing musical ability, and a developmental sequence receive attention. On the basis of what research and theory suggest regarding human musical learning and development, the authors offer some practical suggestions for music education.

In the tradition of prior editions, Chapter 11 speculates regarding future research directions. The authors warn against a growing problem in understanding music's roles in society: the overzealous hasty interpretation of limited research. They also offer some speculation regarding the emerging importance of the neurobiology of music processing.

All chapters reflect the authors' bias that music is a human phenomenon. Individuals bring their prior experiences to the performance and listening situations, where such experiences interact with all the dynamic aspects of human intercourse. Much remains to be learned regarding musical behavior. Its complexities may at times overwhelm the student, teacher, and researcher, but seemingly far-fetched and distantly related ideas may begin to appear with surprising frequency. In the last analysis, musical behavior is but one dimension of human behavior, albeit a very important one for many people–it is no more, and no less. As Gaston (1968, p. 21) said, "Music is not mystical nor supernatural–it is only mysterious."

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Chapter 2

MUSIC, A PHENOMENON OF PEOPLE, SOCIETY, AND CULTURE

Scholars have examined musical behavior from many perspectives, including historical, psychological, philosophical, sociological, and cultural anthropological perspectives, as well as the more specialized perspectives of ethnomusicology, sociomusicology, and sociology of music.[1] Recently, some musicologists have expressed a renewed interest in exploring music's roots as a social and cultural phenomenon (Wallin, 1991; Wallin, Merker, & Brown, 2000). Such interest has stimulated the development of *biomusicology*, an emerging field of study.

Biomusicology examines music's origins and its sociocultural applications. Three subfields include *evolutionary musicology*, the exploration of music's evolutionary origins; *neuromusicology*, the study of neural and cognitive processes underlying musical production and perception; and *comparative musicology*, the examination of music's functions and uses in all human cultures (Brown, Merker, & Wallin, 2000, p. 5). This chapter discusses aspects related to comparative and evolutionary musicology.

Hargreaves and North (1999) maintain that the social context in which musical behavior occurs should be an integral part of music psychologists' approaches to studying musical behavior. In the belief that emphases on cognitive dimensions of musical perception and production during the latter part of the twentieth century led to neglect of musical behavior's social dimensions, Hargreaves and North (1997) argue that any aspect of musical behavior under study must consider "the social and interpersonal context in which musical meaning is constructed" (p. 1). Social functions influencing musical behavior purportedly involve levels of the individual, small and large social groups, and society and culture as a whole (Hargreaves & North, 1999, p. 79).

In short, society and culture evidently have considerable influence on the

[1]Sociology of music focuses primarily on any aspect of musicmaking that influences or is influenced by society (Lundquist, 1982, p. 107). Sociomusicology's interests and concerns are ultimately *musical*. Sociology of music, however, "is not about music but society" (Dasilva, Blasi, & Dees, 1984, p. [illegible]). Nevertheless, each field of study offers insights into society's effects on musical behavior.

musical behaviors of individuals within various social and cultural groups and subgroups. Scholars' current interest in music's role in society and culture makes examination of musical behavior from these perspectives an important focus for any comprehensive examination of the psychological foundations of musical behavior.

Nettl (2000, p. 468) notes that "all societies have vocal music [and] virtually all have instruments of some sort." Merriam (1964, p. 218) indicates that the sheer amount of music present in the world and its central role in many human activities make music a significant force in the shaping and control of much human behavior. While Merriam speaks from an anthropological perspective, with recognition of non-Western arts traditions, music's prominence in contemporary society certainly supports his view. The ever-presence of music today, whether in the concert hall, supermarket, home, house of worship, school, commercial and electronic media, or elsewhere, provides evidence that music is as important today as it has been throughout humankind's history.

For the most part, musical behavior is interhuman, interpersonal, or social (Mueller, 1963). According to Dasilva, Blasi, and Dees (1984, pp. 3–5), music may be social in several senses: (a) performing, creating, hearing, and interpreting music involves using shared social constructs–grammars and symbols; (b) music involves composers, interpreters, and listeners; and (c) music is communal because it occurs in "communities," limited circles in which particular interpersonal and intergroup relationships exist. Dasilva et al. also argue that one can not understand musical behavior, or "conduct" as they prefer, without examination of the social processes involved.

Why Music?

Because people create music, they presumably create it for some purpose, i.e., music serves some *function* within the society in which it is created. Perhaps more accurately, the musical *experience* rather than the music per se is functional. As Portnoy (1963, p. 113) suggests, music's value lies not in the musical structure, but in its effect on people.[2] Thus, from this perspective, music that is of no use to people or has no effect on people might be valueless.

The premise of the present discussion is that music is created by and for people. As Gaston (1968, p. 15) states, "music is the essence of humanness," not only because people create it, but because they create their relationships to it. Gaston maintains that the human brain, which distinguishes people

[2]Advocates of an absolutist or formalist school of aesthetics or people who believe that "good" music is good because of its structure might disagree with Portnoy's suggestion. Aesthetic schools of thought and bases for calling music "good" or valuable are addressed in Chapters 8 and 9.

from other animals by making possible speech and abstract thinking, also enables "significant nonverbal communication in the form of music." Sloboda (1985, p. 268) and Dowling and Harwood (1986, pp. 236–237) also recognize that biological development has been essential to music becoming such a vital part of society and culture, and several essays in the recent Wallin, Merker, and Brown (2000) volume concerning evolutionary musicology provide additional support for this view (e.g., Brown, 2000; Falk, 2000; Freeman, 2000; Merker, 2000).

Notwithstanding some tenuous arguments that bird songs, gibbon songs, and whale songs reflect musical characteristics (Geissmann, 2000; Payne, 2000; Whaling, 2000), most scholars agree that musical behavior is unique to people, but there may be less consensus regarding *why* music exists. While most philosophical inquiry regarding the question examines music as an art form with aesthetic value, anthropologists and ethnomusicologists suggest that music exists because of its enculturational functions (Johnson, 1985, p. 54; Nettl, 1985, p. 69). Music also is recognized as serving additional functions.

Several writers (e.g., Adorno, 1976; Dowling & Harwood, 1986; Frith, 1987; Gaston, 1968; Gregory, 1997; Hargreaves & North, 1997, 1999; Kaplan, 1990; Merriam, 1964; Nettl, 1985; Sloboda, 1985) present views regarding music's functions, and this section considers views from three perspectives: cultural anthropological, sociological, and psychological. As will be evident, the functions identified within each perspective are neither discrete nor exhaustive.

Cultural Anthropological Functions

In his classic work *The Anthropology of Music*, Merriam (1964) identifies 10 broad musical functions. For Merriam, *functions* denote the reasons, in terms of broad purposes, for engaging in musical activity. Although he recognizes that differences exist between nonliterate and literate societies in the ways and situations in which people use music, he maintains that music essentially serves the same basic functions regardless of the particular society or culture, or its level of sophistication. Merriam's oft-cited functions include (a) emotional expression, (b) aesthetic enjoyment, (c) entertainment, (d) communication, (e) symbolic representation, (f) physical response, (g) enforcing conformity to social norms, (h) validation of social institutions and religious rituals, (i) contributions to the continuity and stability of culture, and (j) contributions to the integration of society.

Music as *emotional expression* recognizes that music is a vehicle for expressing ideas and emotions that people might not reveal in ordinary discourse. Music can convey either individual or group emotions. The social protest

songs of the 1960s allowed young people a socially tolerable outlet for expressing anti-Vietnam war sentiments. Songs have been a part of many other movements in which people sought to express political and social displeasure, e.g., the American civil rights movement, the anti-apartheid struggle in South Africa, the 1968 anti-Soviet demonstrations in Prague, and the 1989 Chinese student demonstrations in Beijing's Tianenmen Square. Following the September 11, 2001 "Attack on America," patriotic songs took on a renewed meaning in expressing national unity, as they did for an earlier generation of Americans after Japan's surprise December 7, 1941 attack on Pearl Harbor.[3] On a more personal level, young people often express feelings of love through song. People also use music to express grief, joy, reverie, fright, and virtually any conceivable emotional feeling.

Music as *aesthetic enjoyment*, which is examined more fully in Chapter 8, essentially involves contemplating music in terms of its beauty, meaning, and/or power to evoke a feelingful experience. While philosophers have pondered the exact nature of music's aesthetic function throughout the history of Western civilization, and people continually will debate the aesthetic function's "real" meaning, an aesthetic experience essentially involves seriously contemplating and responding feelingfully to some object or event in terms of its beauty, meaning, and/or power to evoke a feelingful experience. Whether the feelingfulness of the aesthetic experience results from the organization of the sounds themselves, the sounds' "expressive qualities," something external that the sounds might symbolize, or even from the listener's previous associations with the music also will be subject to continual debate. Regardless of the exact nature of and bases for the aesthetic function, making music and responding to its beauty, meaning, or power appear important to most people.

Music functions as *entertainment* in virtually all societies. Distinguishing between the entertainment and aesthetic enjoyment functions, Mussulman (1974, p. 140) suggests that entertainment "engages the attention agreeably" and "amuses or diverts," while art is concerned with aesthetic principles. Whether a given musical experience may both entertain and give rise to aesthetic experience is questionable, but the function served may vary with individual listeners. For the past century, *popular* music, in the broadest sense of the term, apparently was intended to entertain, while *art* music was intended to serve an aesthetic function. While the line between the two broad styles is becoming increasingly blurred, and, obviously, popular music may give

[3]People may find new expressive uses for songs that arose at earlier times. Irving Berlin's "God Bless America," originally appearing just prior to World War II, took on renewed importance at large gatherings (such as football games) in the USA following the events of September 11, 2001. "We Shall Overcome," the unofficial anthem of the 1960s civil rights movement, was heard at the Prague demonstrations and, years later, at rallies following the September 11 events.

rise to aesthetic feelings and art music may entertain, the basic intents of popular and art music apparently remain the same today. Certainly, music to entertain is a major industry in itself, and when commercial values (e.g., planned obsolescence so that new music and recordings may be sold, the careful "packaging" of performers, marketing tee shirts and lunch boxes with performers' likenesses) override artistic values, one may question such music's potential to serve an aesthetic function. However, one can not deny that highly commercialized and financially successful undertakings such as Andrew Lloyd Webber's musicals *Jesus Christ Superstar, Evita, Cats,* and *The Phantom of the Opera* resulted in aesthetic experiences for millions of people. Or were they just being entertained?

Hargreaves and North (1999, p. 74) also recognize that the aesthetic enjoyment and entertainment functions are interlinked and suggest that an individual's response to a given piece of music depends on the interaction among the characteristics of the *person,* the *music,* and the *situation* in which it is encountered. Further, they note that most research regarding such response has focused on characteristics of the person and the music while tending to ignore the importance of situation characteristics. They argue that redressing this research imbalance is an important task for investigators.

Merriam suggests that music's function as *communication* perhaps is the least understood of his 10 major functions. Adamant that music is no "universal language," Merriam contends that music is shaped by the culture of which it is a part. Cross (2001) notes that efforts to develop a cross-cultural perspective on music reveal that music involves a "multiplicity of reference and meaning" (p. 99). Even within a culture, that which music communicates usually is imprecise. Its communicative meaning particularly depends on the extent to which individuals within the culture have shared experiences regarding the musical idioms and what they convey. Even then, it is unlikely that individuals with shared experiences will derive the same meaning from a given musical experience. As suggested previously, any mood or emotion conveyed by music also depends on several variables external to music itself: A listener's personality and other attributes that contribute to his or her uniqueness as an individual, the mood he or she holds just prior to the musical experience, any word meanings conveyed by the music (if any exist), and the listener's attitudes toward music in general and the particular music heard all affect any mood or emotion resulting from the musical experience.

In virtually every culture, music may function as a *symbolic representation* of other things, ideas, and behaviors. In serving this function, whatever music symbolizes or represents must be of a nonmusical nature. These things, ideas, and behaviors may include cultural values, other group or individual values, abstract ideals, or occasions that hold particular affective meaning. A national anthem may symbolize a nation's values and traditions. Protest songs often symbolize social or political movements, and school songs and theme songs of other organizations have symbolic value for members of those organizations. Theme songs for individual performers, for radio and television programs, and even for products promoted in advertising jingles also have a certain symbolic value, although it is doubtful that the symbolic representation in these instances reflects the profundity of cultural symbolism that Merriam suggests.

Music gives rise to *physical response,* and all societies use music integrally with dance and other rhythmic activities. Music elicits, excites, and channels crowd behavior, although the culture shapes the nature and extent of the behavior. Chailley (1964, p. 62) suggests that an important part of religious ritual in primitive societies was to draw the worshiper "out of himself, to excite him and . . . to put him in a state of ecstasy." Chailley also suggests that religious ritual that uses music solely for creating tranquility and contemplative meditation is against human nature.[4] Perhaps the music of contemporary Christian rock and gospel groups, which by its very nature tends to elicit more physical response than traditional church music, is capitalizing on music's basic movement function.

According to Merriam, *enforcing conformity to social norms* is one of music's major functions, particularly in primitive cultures. Songs of social control play an important part in many cultures by providing either direct warning to erring members of the society or by indirectly indicating what is considered proper behavior. Protest songs often indicate the improprieties of society as well as the proprieties. Many songs for young children, including both traditional folk songs and certain songs specifically devised for preschool and early elementary children, serve to reinforce the values and ideals that parents, schools, and society wish to instill in young children.

Closely related to the preceding function is music's use to *validate social institutions and religious rituals.* Songs that emphasize the proper and improper in society and songs that tell people what to do and how to do it serve this function. Songs of fraternal organizations, church youth groups, and many other organizations that wish to establish and preserve their traditions and ideals also serve this function.

Perhaps all of the foregoing functions relate to Merriam's ninth function, the *contribution to the continuity and stability of culture.* As Merriam (1964, p. 225) states:

> If music allows emotional expression, gives aesthetic pleasure, entertains, communicates, elicits physical response, enforces conformity to social norms, and

[4]Practitioners of some Eastern religions as well as of Christian contemplative prayer would question Chailley's argument strongly.

validates social institutions and religious rituals, it is clear that it contributes to the continuity and stability of culture. . . . Music is in a sense a summatory activity for the expression of values, a means whereby the heart of the psychology of a culture is exposed without many of the protective mechanisms which surround other cultural activities.

Merriam goes on to suggest that music's very existence provides a normal and solid activity that assures a society's members that their world is continuing in the right direction. Music continues to serve this function today. Since the 1950s, American adolescent subculture has had various forms of music with which to identify, music that teenagers feel is "their" music. Folk songs from the "old country" may provide immigrants and their descendants with a cultural link to the past. In addition to their religious and entertainment functions, traditional Christmas and Hannukah songs provide a certain stability across generations.

Perhaps music's most important function from Merriam's perspective is its *contribution to the integration of society.* If nothing else, music draws people together: It invites, encourages, and in some instances almost requires individuals to participate in group activity. People who might otherwise never interact will work together in making music. Farrell's (1972) study of the meaning of the choral experience for adult amateur singers and Hylton's (1980) study of high school choral groups both revealed that social interaction was a highly meaningful aspect of the choral experience. Mills's (1988) study of the meaning of the high school band experience yielded similar results. In short, music making brings people from differing sociocultural, religious, occupational, and musical backgrounds together for a common musical and social experience. As Hargreaves and North (1999, p. 75) note in their reinterpretation of Merriam's functions, "all 10 of the functions . . . have a social dimension at their heart."

In summary, Merriam's 10 musical functions reflect an anthropological perspective and suggest that since its beginnings, music has helped and served people by (a) integrating individuals into society, (b) teaching the society's institutions and rituals, and (c) generally contributing to cultural stability and continuity. While the nature and forms of music vary from culture to culture, and the directness with which various cultures have *used* their music functionally also varies, Merriam's functions continue to have merit in contemporary cultures.

Sociological Functions

Material for this section is drawn primarily from three sources: Frith (1987), Kaplan (1990), and Hargreaves and North (1999). Frith describes the social functions of popular music, while Hargreaves and North examine music's social functions in the context of their impact on an individual's everyday life. Kaplan, both a sociologist and a musician, writes in terms of the social functions of the *arts,* but the functions he identifies seem particularly descriptive of music's functions.

Frith (1987, pp. 140–144) identifies four functions of popular music: (a) to create a type of self-definition, a particular place in society; (b) to provide a way of managing the relationship between one's private and public emotional lives; (c) to shape popular memory, organize one's sense of time, and intensify a given experience; and (d) to provide a sense of musical *ownership.*

Kaplan's (1990) functions include art [read *music*] as (a) a form of knowledge; (b) collective possession; (c) personal experience; (d) therapy; (e) a moral and symbolic force; (f) an incidental commodity; (g) a symbolic indicator of change; and (h) a link among the past, present, and scenarios of the future.

Art as a *form of knowledge* is an aesthetic knowledge based on the "essence of originality in putting together things, objects, ideals, sounds, forms, and space and time relationships in ways that have not been done before, but on the principle of beauty" (Kaplan, p. 20). Such knowledge also involves subjectivity, the essence of which is undefinable. This subjectivity, Kaplan maintains, gives art its strength and reason for being.

The arts may be the *collective possession* of a state, fraternal organization, political group, or other social group and may be useful in some ritual or to commemorate some special events. When arts are used in this way, they serve both to "identify the persons who watch or listen with the intended group interests and values" (Kaplan, p. 30) and to fulfill some particular social, political, or propaganda end.

Frith notes that young people, in particular, consider popular music as a possession and that they also feel they possess "the song itself, the particular performance, and its performer" (1987, p. 143). Frith as well as Hargreaves and North (1999) also agree that music plays an important role in adolescents' identification and delimitation of their social groups. Adolescents use "their music" as a means for *including* others into their social groups and *excluding* still others; i.e., if you like our music, you are one of us; if you do not, you are not.

The arts as *personal experience* may provide a means by which an individual can remove himself or herself from a group, thereby weakening personal reliance on the group (Kaplan, p. 30). Music and arts from other eras may allow a certain escape from the present and an opportunity to experience the past vicariously. Kaplan maintains that art as personal experience also may provide the "opportunity for relaxation, memory, fragmentary or sustained enjoyment, contemplation, or any other subjective mood or need" (p. 31). Hargreaves and North (1999) consider music's role as a tool for managing an

individual's mood to be one of music's three main social functions for the individual.

The arts, and particularly music, as *therapy* have evolved over the past half century into recognized respectable professions. Kaplan notes that in the very process of singing or playing an instrument, "something happens." That which happens often is difficult to explain, but Kaplan suggests that a handicapped individual's mere participation in group music-making experience involves a type of communication, something which often is not possible for such individuals through normal verbal discourse. Kaplan suggests that in a period of growing anxieties in society, the medical profession may show an increasing interest in such symbolic communication as the arts offer.

The arts' values as *moral and symbolic forces* may articulate concepts that are "external to the arts but important to society: God, freedom, love, bravery, youth, joy, or sadness" (Kaplan, p. 32). Noting that the arts may teach "proper responses or attitudes towards values and institutions of the society" (p. 32), Kaplan acknowledges that one can not distinguish clearly the arts as symbolic and moral forces from *collective possession,* and cites music's long history as a propaganda tool. However, he goes on to note a more general sense in which art is a symbolic force in all societies: as *play.* He maintains that saying we "play" music or are "playing" an instrument is more than a figure of speech. Participation in music and the other arts purportedly "transcends the immediate need of life and imparts meaning to the action" (p. 33).

As a sociologist, Kaplan is interested particularly in the arts as *incidental commodity.* He notes applications of the arts in radio and television for which profit is a primary motive. He views musicians and other artists who work in these media simply as employees engaged for a specific task. Kaplan's comprehensive model for the arts in society sees the roles of creators and distributors of art as intertwined and involved directly with the arts as a commodity. While this particularly is the case for music in the various popular and entertainment idioms, it also is evident for some art music. In short, music is both a process and product through which many individuals in today's society are able to realize commercial gain.

Kaplan also views the arts as *indicators and forerunners of social change* and notes that this function "is so obvious that it risks being ignored" (p. 34). Music both shapes and is shaped by society, and students of music history are cognizant of music as a reflection of the life and social conditions of the various historical eras. Contemporary youth music provides a notable example of a group's social values being both reflected in and promulgated by the group's music.

Perhaps the most important function of the arts for Kaplan is their role as a *link between the past, present, and scenarios of the future.* Contrasting the creativity of artists with the creative efforts of the scientist, Kaplan notes that artists produce works that might be tested or evaluated subjectively rather than empirically by their colleagues and the public. He suggests, however, that it is the "subjective nature of the arts, and its accumulative nature as a part of every culture, that gives it the unique stability to which the scientist may turn for his own sense of stability in his objective, experimental world" (p. 37). He maintains that future generations will continue to hear great works, such as Beethoven's *Ninth Symphony,* which thereby serve as a link from the past, through the present, and into the future. Such an important function, Kaplan argues, makes music "a basic form of knowledge and a major cultural value" (p. 37).

Hargreaves and North (1999) summarize music's social functions in everyday life for the *individual,* noting that they are manifested in three basic ways, facilitating "the management of *self-identity, interpersonal relations,* and *mood* (p. 79). The self-identity and interpersonal relations functions should be evident from the foregoing discussion. Chapter 8 will address music's role in managing mood.

Psychological Functions

In Gaston's (1968, pp. 7–29) classic essay on "man and music," he identifies eight *fundamental considerations* of people in relation to music. Since Gaston's considerations focus primarily on music's contributions to *individual* well-being rather than to culture or society, one usually considers them as *psychological functions.* The eight considerations include (a) the need for aesthetic expression and experience, (b) the influence of the cultural matrix on the mode of expression, (c) the integral relationship between music and religion, (d) music as communication, (e) music as structured reality, (f) music's relationship to the tender emotions, (g) music as a source of gratification, and (h) music's potency in a group.

Gaston viewed the *need for aesthetic expression and experience* as essential to the development of humanness, and considers sensitivity to and the making of beauty to be one of humankind's most distinguishing characteristics. Gaston goes so far as to suggest that individuals who are insensitive to beauty–whether in music or elsewhere–are not achieving their full human potential, and even may be handicapped.

While not a function per se, the view that the *cultural matrix in which an individual lives determines the mode of expression* is fundamental to Gaston's functions of music for an individual. While music serves similar functions in nearly all cultures, *individuals* usually respond only to functional music of their own culture, i.e., they learn the music of their own culture and generally react to it in terms of the way their particular society reacts to it.

The *integral relationship of music and religion* is evident in virtually every cul-

ture. Gaston believes the primary reason for this is that religious services and musical performances have some common purposes, the greatest of which is their valence for drawing and bonding individuals into a group. Music and religion go together to defend an individual against fear and loneliness. Music also seems to be particularly appropriate for helping an individual communicate with the supernatural, a concern of many religious rites.

For Gaston, the importance of *music as communication* is in its utility as non-verbal communication, which provides music with its potency and value. Gaston maintains that people would not need music if they could communicate verbally that which is easily communicated musically. Even the best verbal descriptions of feelings expressed by music fail to communicate the feelings adequately. Perhaps it is because music's meaning is wordless that philosophical explanations of music's meanings, verbose though they may be, are somehow inadequate.

That *music is structured reality* should be evident to any student of music therapy. The fact that music is a time-based auditory phenomenon does not make it any less sensorily tangible than objects which people touch, see, taste, or smell. Gaston maintains that music therefore is a particularly valuable therapeutic medium through which individuals who have withdrawn from society may reestablish contact with a structured reality. That music provides a structure for encouraging withdrawn individuals to interact with others is the premise underlying Gaston's fundamental principles of music therapy.

Gaston's contention that music is *derived from the tender emotions* is reflected clearly in most popular music, as well as in most religious music, folk songs, art songs, and patriotic music. Most such music reflects a concern for other individuals, and the predominant theme is love in one of its various manifestations–love of one another, of country, of God, etc. Such music also may provide an individual with a feeling of belonging, thus providing a sense of closeness to others and alleviating loneliness.

> In our culture, as well as in others, *music is nearly always an expression of good will, a reaching out to others,* and is so interpreted. Music, then, is a powerful expression of the interdependence of mankind, and from the lullaby to the funeral dirge, an expression of the tender emotions. (Gaston, 1968, p. 25)

The recognition of music *as a source of gratification* is particularly apparent in children and adolescents, although adults certainly may attain a sense of gratification from musical experience. Gratification in this sense is a by-product of achievement per se rather than competition, and music provides opportunities for achievement in noncompetitive situations. The self-esteem that results from musical accomplishment contributes greatly to an individ-

ual's state of well-being.

That *the potency of music is greatest in the group* should be self-evident. Music is a social phenomenon that invites and encourages participation. Music provides group activities that bring together individuals who otherwise might not come in contact with one another. Group musical experience provides people with opportunities to interact in intimate yet ordered and socially desirable ways.

In short, music has contributed to the well-being of individuals throughout history, and Hargreaves and North (1999, pp. 75–77) maintain that music continues to be important to individuals at several levels of everyday life: (a) the *intraindividual* level, reflecting its role in enhancing self-concept and facilitating emotional expression; (b) the *interindividual* level, reflecting the importance of significant peers on one's musical performance and listening behaviors; (c) the *social-positional* level, reflecting music's role in the development of friendship patterns and group identification in adolescence; and (d) the *ideological* level, reflecting music's role in helping an individual to learn the ideals of his or her culture.

The preceding section considered music's functions from three broad perspectives (cultural anthropological, sociological, and psychological), but it is obvious that many commonalities exist among the functions encompassed within the three perspectives. Also, the various functions are not discrete; given musical experiences may serve a variety of functions for most people in virtually every culture and society. While some cultures, particularly Western ones, may place greater emphasis on an aesthetic function, all functions contribute to music's importance to individuals, society, and culture.

Another Perspective

While the perspectives discussed offer answers to "Why music?" in terms of music's contributions to individuals, societies, and cultures, several writers have pointed out that the development of music's importance to humankind is more than a sociocultural phenomenon. As Cross (2001, p. 95) notes, "the emergence of evolutionary psychology over the last decade has prompted an increasing number of researchers to consider why it is that humans have come to be musical." This evolutionary perspective suggests that music's importance to humankind is integrally related to biological development and that it is the interrelationships between biological and cultural evolution that led to music becoming such an important aspect of human behavior (e.g., Brown, Merker, & Wallin, 2000, pp. 18–20; Cross, 2001; Dowling & Harwood, 1986, pp. 236–237; Molino, 2000, pp. 166–168). Brown, Merker, and Wallin observe that the term *music evolution* is somewhat ambiguous because it refers both to biological evolution of a human capacity and cul-

tural evolution of that capacity's output. Molino cautions that cultural evolution involves more than just the type of biological evolution associated with Darwinism.

Trehub's (2000) examination of human predispositions for processing music supports the notion of a biological basis for several aspects of music processing. As evidence, she notes substantial infant-adult similarities in music perception. Her excellent review of her and others' research indicates that both infants and adults tend to focus on *relational cues* (e.g., pitch and temporal patterning) rather than *absolute* pitches and durations when processing auditory patterns. On the basis of her findings, Trehub proposes three processing universals: "the priority of contour over interval processing; the priority of temporal patterning over specific timing cues; and the relevance of gestalt [sic] principles of grouping" (p. 431). Trehub suggests that the "striking similarities between infant listeners with minimal exposure to music and adult listeners with extensive exposure to music make a compelling case for inherent perceptual biases in relation to music" (p. 436). She goes on to argue that these information processing constraints may have implications for the development of musical systems across cultures and that "one consequence of musical cultures building on perceptual processing predispositions is that exposure and training often lead to progressive improvement in the skills that are favored by nature" (p. 436). In short, Trehub suggests that music processing tendencies and restraints may have influenced the structural nature of the musics contained within the world's various cultures.

In raising the question "Does man *need music?*" Sloboda (1985, pp. 260–268) notes that individuals can go without music for very long periods of time without showing any noticeable ill effects. He suggests that *cultures* rather than individuals need music and that the "need" might be more direct in nonliterate cultures than in today's complex contemporary societies. In his words (p. 267),

> primitive cultures have few artifacts, and the organization of the society must be expressed to a greater extent through transient actions and the way people interact with each other. Music, perhaps, provides a unique framework with which humans can express, by the temporal organization of sound and gesture, the structure of their knowledge and social relations. Songs and rhythmically organized poems and sayings form the major repository of human knowledge in non-literate cultures.

Sloboda suggests that human mental processes, which he views as a product of evolution, have led to a natural propensity to behave in adaptive ways, including a propensity to use language and music. He maintains that evolution supplied a *motivation* for music, making it "natural" and enjoyable for people to indulge in it.

Advocating a similar position, Dowling and Harwood (1986, pp. 236–237) suggest that we should consider evolution in terms of the *gene pool of groups* rather than in terms of *individual adaptations*. They agree that music is valuable to human groups and note that as humans evolved over hundreds of thousands of years in small groups, singing and playing music served as a "cohesion-facilitating group activity–an expression of social solidarity" (p. 236). They recognize music as a powerful symbol of cultural identity, especially since musical style tends, like language, to reflect a highly stable set of culturally transmitted shared behaviors. They maintain that music's value to human societies reflects music's *biological adaptive value*. Furthermore, they maintain that even with changes in social structures and other developments that have come with industrialized societies, including some division of labor between "musicians" and "consumers," music's sociocultural values and the underlying distribution of musical abilities are essentially the same as in more primitive societies.

Finally, Brown (2000, pp. 296–297), as an outgrowth of his "musilanguage" model of music's origins, discussed later in this chapter, observes that "music making has all the hallmarks of a group adaptation and functions as a device for promoting group identity, coordination, action, cognition, and emotional expression. . . . Music making is done for the group, and the contexts of musical performance, the contexts of musical works, and the performance ensembles of musical genres overwhelmingly reflect a role in group function."

The answer to "Why music?" continues to be in terms of the many important functions that music serves in society and culture. Perhaps increased understanding of the role of biological evolution, including information-processing tendencies and constraints, in the development of human adaptive behaviors will provide at least a partial answer as to "how" music became so important to human society and culture.

What Makes Some Sounds Music?

Studies of the development of musical behavior suggest that differential response to musical sound and other sound becomes evident during infancy (Dowling, 1984; Moog, 1976; Trehub, 1993, 2000). Virtually every child and adult "knows" what music is–at least the music of his or her surrounding culture. The enculturation process assures that early in life, children develop a concept of music, albeit vague, ill-defined, and largely unverbalized. That individuals' concepts reflect cultural bias is readily apparent, although most individuals will recognize another culture's music as *music*, even though it may sound "strange."

Whatever the culture, music involves an organization of sounds and

silences, encompassing various pitches, loudness levels, and timbres, all of which occur within a rhythmic framework. Music is a time-based art form. Its organization across time determines the pace at which a listener hears a sequence of sounds and silences.

Of course, all sounds are temporal, and all sounds have a certain loudness level and sound quality or timbre. One can argue that all sounds, even obvious noises, have a certain relative pitch level, even when the pitch is rather indefinite and/or continually changing. While one cannot match pitch vocally with the sound of a food blender or a truck rumbling by on a highway, the truck usually sounds lower in pitch than the blender. Despite the traditional definition of music as organized sound and silence, one may hear discernible organization in sounds generally considered nonmusical, e.g., speech, certain machinery sounds, and many natural sounds, especially if they have a repetitive quality. Some contemporary music–*musique concrete*–incorporates sounds of nature and other environmental sounds into a recognized musical style.

So, why are people more likely to organize some sounds into and hear them as music than others? Blacking (1973, p. 10) argues that music could not exist if people had not developed a capacity for structural listening, i.e., the ability to perceive *sonic order*. He goes on to argue that understanding music involves both sound (the object) and person (the subject); for Blacking, the key to understanding music is in subject-order relationships, the activating principle of organization (p. 26).

Arom (2000, p. 27) notes that all human music involves some sort of formal process and has an individual time frame. Most human music is measured, i.e., it is subject to an "isochronous temporal pulse" or underlying beat that allows coordinated group activities. Indeed, without the underlying pulse, which Arom considers a "quasi-universal," dance and other group music activities would be virtually impossible. Merker (2000, pp. 315–320) maintains that an underlying regularly spaced beat or pulse is a primary organizing device for most musics. He notes that most tempo changes either are very gradual or conform to whole integer ratios of a given tempo. He also recognizes that the even pace is subject to manipulation for expressive purposes, but the expressiveness is in relation to the underlying beat.[5]

Certainly, vast differences exist in human musical cultures, but the basic human ability to organize sounds and silences into music may be based in human biology. Carterette and Kendall (1999) discuss cross-cultural organizational principles, rooted in human perception and cognition, that enable people to make musical patterns from auditory stimuli. In their need to organize and make sense of continuous inputs of sound, people must group and reduce

[5]Expressive timing is discussed in Chapter 5.

the sounds to fit into human perceptual and cognitive capacities. One musical example of such reduction is the octave, where tones of a similar quality or chroma share a certain commonality and thereby facilitate frequency grouping. Another example is the reduction of frequency ranges into discrete scale systems. People reduce and organize sounds into patterns, and Carterette and Kendall (p. 781) believe that two basic principles enable pattern creation: *contrast* and *periodicity*. People observe and employ differences, boundaries, limits, and changes in visual and aural stimuli; such differences provide contrast. People notice and produce recurrence and redundancies in time and space; these establish periodicity. Just what variables people contrast and how they make them periodic distinguish particular musical cultures.

Carterette and Kendall suggest that musical "universals," particular features or patterns constructed from sonic information, arise from biological structures in which the underlying cognitive systems for music and language exist. Regarding possible universals, which are not factual data such as a tuning standard or the particular frequencies comprising a scale, they note (p. 780):

> Some possible universals are (a) a deep-structured musical idea, (b) elementary auditory grouping strategies, (c) the use of a stable reference pitch, (d) the division of the octave into scale steps, (e) the use of reference pulses, (f) the indication of rhythmic patterns by an asymmetrical subdivision of time pulses.

Considering further possible acultural musical commonalities, Richman (2000, pp. 303–305) suggests that music, in all its varied cultural forms, is built and organized around the principle of *repetition* (or repetition with variation). Conceiving music as an ongoing, dynamic process involving human participation, Richman recognizes three *redundancy devices* that greatly facilitate recognition of and participation in music: music's structural *repetition*, its high level of *formulaicness*, and the high sense of *expectancy* its repetitiveness generates. Formulaicness refers to the "storehouse of preexisting formulas, riffs, themes, motifs, and rhythms that people bring to music making (and vary and play around with)" (p. 304). For Richman, that which makes some sounds music involves more than just the sounds' structure; it involves repeated experiences with those sounds, the development of a storehouse of memories of those sounds, and musical expectations regarding what might come next in the musical experience.

No one answer to the "what makes some sounds music" question is acceptable to everyone, but some sounds obviously are easier to organize into music than other sounds. One basic difference between most naturally occurring sounds and most sounds deliberately created for music is that the naturally occurring sounds are "constantly changing from instant to instant

in the frequencies present and in the amplitudes of the frequencies" (Beament, 1977, p. 7). Beament notes that music primarily involves sounds with sustained constant frequencies (heard as fixed pitches) without which melodic and harmonic music could not occur. He maintains that fixed pitches "are virtually an *artefact* [sic] *of man*."

The use of fixed pitches in music is virtually universal, and psychophysiological explanations of music processing support the need for such use. Roederer (1995, p. 179) maintains that fixed pitches are essential for perceiving music. A tone must last a minimum amount of time in order for the brain to process it as a tone. Sounds of continually changing frequencies do not allow sufficient processing time. In everyday terms, it is easier to identify pitches of sounds that have a certain minimal duration than pitches of sounds that pass by rapidly. Roederer also suggests that most cultures employ recurring patterns of a relatively small number of fixed pitches per octave because the brain can more easily identify, process, and store a melody comprising a set of related discrete pitch values sequenced across time than a rapidly changing pitch-time pattern that sweeps continuously over the entire frequency range.

While most musics indeed appear to use fixed pitches, one should note that the range of musical sounds has additional attributes for which "reasons for being" are inadequate. The universals that Carterette and Kendall (1999) propose, cited above, are based in biology; Sloboda (1985, pp. 253–259) recognizes similar musical universals. He notes that virtually all music is organized around fixed *reference* pitches, such as a drone or tonal center. He also notes that the octave is a "privileged" interval, frequently used in nearly all music, and that scales in virtually all cultures are unequal divisions of the octave. A fourth universal involves the use of pulse or meter to provide *time reference* points. Sloboda argues that both pitch and time reference points are essential for people to coordinate their behaviors in such a way as to make music a structured social phenomenon.

To constitute music, sounds must be structured in such a way that people can make sense of them. Music is a human perceptual phenomenon, and the attributes of fixed pitches, a tonal center, octave equivalence, scales with unequally sized intervals, and time reference points, common to most musics, greatly facilitate perception. They provide the necessary repetition (or structural redundancy). Beyond the structure, however, music makers and listeners bring a lifetime of experience with music of their culture (*formulaicness* or cultural redundancy) that allow them to develop expectations about what comes next in the music they are making or to which they are listening.[6] Finally, and perhaps most important of all criteria for human music, is *intentionality* (Arom, 2000, p. 27). People create music for a purpose. While we may never reach consensus regarding answers to "Why music?" or "Why is this music while that is not?", any answer must encompass more than any objective ordering of sounds. Answers must recognize that music is a human construct, with certain psychophysical, perceptual, cognitive, and behavioral potentials for interacting with sound constructs. Finally, the answers must recognize that musical sounds vary from culture to culture, yet share structural constraints and many similar functions.

The eventual answer to "What makes some sounds music?" must be in terms of those sounds' *function* within a given cultural context. Musical sounds are (a) created or combined by a human being, (b) recognized as music by some group of people, and (c) serve some function which music has come to serve for a given social group or culture. Ultimately, musical sounds are those sounds that people are willing to accept as music.

Origins of Music

Obviously, the study of music's origins is fraught with many difficulties, not the least of which is music's temporal nature, which provides anthropologists and archaeologists with few artifacts for determining the nature of early people's musics, and still fewer clues to music's origins. Such a void has given rise to considerable myth, legend, speculation, conjecture, and theory. People have passed down myths and legends through many cultures, perhaps from prehistoric times, but certainly from the cultures of antiquity and many primitive cultures studied by anthropologists and musicologists.

In the late nineteenth and early twentieth centuries, scholars demonstrated an interest in searching for music's origins. Revesz (1954, p. 218) suggests that perhaps Darwin's (1874) theory of evolution provided the impetus for such interest at that time. Although many have questioned the sophistication and accuracy of the nineteenth and early twentieth century scholars' speculations regarding music's origins (e.g., Blacking, 1973; Chailley, 1964; Nadel, 1930; Nettl, 1956; Revesz, 1954; Wallaschek, 1893/1970), speculative theories of that era held a certain fascination and even plausibility for many.

Many early speculative theories of music's origins were rooted in music's potential for facilitating communication, at least in a broad sense of the term, and several of the communication-related theories postulated a close relationship between the development of language and music. Other early speculative theories include the *mating call* or *Darwinian theory*, a *theory of imitation*, a *theory of rhythm*, a *work song theory*, a *calling signal theory*, and several theories related to emotional speech (e.g., *speech theory* (Wallaschek), *theory of expression* (Revesz), *theory of impassioned speech* (Nettl)). Readers interested in reviews and critiques of these early theories should consult Nettl (1956),

[6]Chapters 6 and 8 discuss further the roles of structural and cultural redundancy.

Revesz (1954), Sloboda (1985), or Wallaschek (1893/1970).

Brown, Merker, and Wallin (2000, p. 3) note that evolutionary approaches to music's origins fell into obscurity and even disrepute after the 1940s, perhaps due to two factors: rejection of racist notions present in much European scholarship before World War II and the rise of the cultural-anthropological approach to musicology in the United States during the post-war period. Whatever the cause, interest in music's origins waned through most of the remaining twentieth century. A resurgence of interest came with Wallin's (1991) coining of the term *biomusicology,* which included the three branches of *evolutionary musicology, neuromusicology,* and *comparative musicology.* The excellent volume *The Origins of Music* (Wallin, Merker, & Brown, 2000) certainly has brought focus to evolutionary musicology as a field of study and undoubtedly will stimulate much thought, research, and speculation regarding music as an evolutionary process. Much of this section draws heavily on some theories offered in that volume. Prior to examining those theories, however, we will examine some of the mythology about how music came to be.

Chailley (1964, pp. 1–11) and Wallaschek (1893/1970, pp. 259–262) summarized some of the myths and legends, most of which suggest that some supernatural being gave music to people. One Hindu myth holds that Brahma, the supreme spirit of the universe in Hindu theology, invented music as the goddess of speech, Saraswati. A Chinese legend dating from the third century B.C.E. says that the Chinese musical scale came from six tones sung by Fung-Hoang, a magical bird. However, Durant (1963, p. 273), offering a different, nonavian account of the origin of Chinese music, ascribes music's origin to the legendary emperor, Fu Hsi. Japanese tradition holds that music came from the gods themselves, perhaps devised to lure the sun goddess from a cave to which she had retreated.

The Sumerians had the goddess Nina as the patroness of music, while the Assyrians called their goddess of love, Ishtar, "the harmonious and sweet-toned flute" (Chailley, p. 6). Greek mythology recognized several gods and goddesses associated with music: Euterpe, a muse of song; Athena, creator of the flute; the god Pan, who created the pipes of reeds; and Hermes, who created the shepherd pipe for himself and the lyre for Apollo, the god of music (Portnoy, 1963, p. 241). Perhaps the most far-reaching Greek myth about music was that of the "harmony of the spheres," which originated with the Pythagoreans and subsequently became the basis of Plato's philosophy of music.[7]

[7]Essentially, harmony of the spheres refers to characteristic music of heavenly bodies, a part of the divinely ordained "celestial" music, with which people might interact through mathematics. For information regarding this view, see Walker (1990).

The Hebrews were among the few people of antiquity who considered music's origin to be historical rather than supernatural. The Bible credits music's invention to Jubal, a seventh generation descendant of Cain, the elder son of Adam and Eve. "He was the ancestor of all those who play the lyre and pipe" (Genesis 4:21 (Meeks (1989)).[8]

Contemporary theories, many of which still involve a high degree of speculation, have several advantages over the early theories. Nearly an additional century of multidisciplinary study and research, including tremendous advances in knowledge of human neurobiological development and research in cultural anthropology, sociology, psychology, ethnomusicology, and related interdisciplinary considerations, provide contemporary theorists much stronger bases and perspectives for postulating about music's origins. The balance of this section presents overviews of several contemporary theories: (a) Brown's *musilanguage theory;* (b) Miller's updated account of the *sexual selection theory;* (c) Merker's *synchronous chorusing theory;* (d) Dissanayake's *mother-infant interaction theory,* which in many respects is similar to Gaston's (1968) *beginnings of family theory;* and (e) a theory implied in previous sections of this chapter, the *music as an adaptive social force theory.* Readers interested in exploring theories related to music as imitation of bird and other animal "songs" should consult Section II of Wallin, Merker, and Brown (2000). The present authors question the plausibility of such theories and consequently chose not to review them.

Brown's (2000) *musilanguage theory or model* is a sophisticated extension of earlier theories which held that language development and music development were outgrowths of an early evolutionary communication stage that was neither clearly language nor music (e.g., Nadel, 1930; Nettl, 1956; Revesz, 1954). The musilanguage model focuses on the structural features of the two systems, and therefore is considered a structural rather than a functional model. Brown's carefully conceived and highly detailed model suggests that language and music evolved from a "common ancestral stage" that preceded their evolution into distinct systems with differentiated features (p. 278). This common ancestral stage was the musilanguage stage, which had two substages and reflected three essential features: substage one–*lexical tone* and substage two–*combinatorial formation of small phrases* and *expressive phrasing principles.* The first substage involved use of discrete pitch levels to convey broad semantic meaning; the second substage involved the "generation of phrases by the combinatorial arrangement of unitary lexical-tonal elements" (p. 279). Such phrases could have two levels of meaning: *local,* which simply involves the sum of the meanings of the lexical-tonal units, and *glob-*

[8]Alternative translations name different instruments and may refer to Jubal as a "father" rather than an "ancestor."

al, which suggests broader phrase-level meanings. The expressive phrase principles involved "use of local and global modulatory devices to add expressive emphasis and emotive meaning to simple phrases" (p. 279). Brown considers the expressive phrasing principles a critical component of the model, noting that they allow for *sentic modulation*, or changes in the intensity of emotional expression, which he considers both cross-modal (music, speech, and gesture) and cross-cultural. In essence, the musilanguage model hypothesizes that both music and language evolved from a common tonal system.

Brown recognizes that the complete musilanguage model necessarily needs two additional features: It must account for some *precursor* to the musilanguage stage, and it needs to identify some *divergence process* whereby the musilanguage stage evolved into the distinct systems of language and music. With regard to the precursor, Brown suggests it involved *referential emotive vocalizations*, which have "both emotive meaning and referential meaning, a property shared with the musilanguage stage" (p. 291). Such vocalizations are similar to calls of some primates that refer to some object in the environment and at the same time provide a general warning to others to take appropriate escape behaviors.

Brown characterizes divergence as the process by which the analogous and distinct features of music and language evolved (p. 292). The phonological-level units for language include phonemes, words, and phrases; for music, they include combinations of pitches and rhythms into motivic and metric units. In Brown's words (p. 296),

> divergence occurs due to the reciprocal elaboration of either sounds as referential meaning or sound as emotive meaning, ultimately making language and music different in emphasis rather than in kind. This is accompanied by an important divergence of syntax types: language's propositional syntax is based on relationships between actors and those acted upon; music's blending syntax is based on pitch blending and pitch patterning leading to complex sound-emotion relationships. This establishes language's symbolic capacity for representation and communication and music's acoustic mode (with its sound-emotion system and broad semantics).

To summarize, Brown recognizes a *referential emotive vocalization system* as precursor to his *musilanguage stage*, which includes the common ancestral features of both language and music. *Divergence* into language and music systems following the *musilanguage stage* occurs as some sounds take on referential meaning (language) and others take on emotive meaning (music's *acoustic mode* in Brown's terms). Finally, Brown recognizes an *interactive stage*, which involves a rebinding of music and language into what he terms music's *vehicle mode*, which involves combinations of language and music. This interactive stage, he contends, takes place simultaneously with the divergence process and leads to such things as verbal songs, iconic representation, and musical narration.

Previously called the mating call theory, the *sexual selection theory* holds that music's origin is rooted in human sexual instincts and that the earliest form of music was a form or extension of a mating call (Darwin, 1874, p. 652). Although many (Nettl, 1956, pp. 134–135; Revesz, 1954, pp. 224–227; Sloboda, 1985, pp. 265–266) highly criticize the early theory, which may elicit visions of Tarzan and Jane, proponents cite the mating calls of some animals and bird songs that serve a sexual function–sounds or songs used in selecting a mate. Critics note that (a) birds "sing" outside of mating season; (b) music-like mating calls are absent among apes; and (c) if the theory were true, music of today's primitive cultures should be preponderantly love songs related to seeking a mate.

Miller (2000, p. 355), however, argues that scholars have dismissed the functional analogs between human and animal mating calls, or "acoustic courtship" as he terms them, "too readily, too contemptuously, and with too little appreciation of sexual selection theory." Miller suggests that an *adaptationist approach* is a useful extension of the sexual selection theory of music's origins. He considers human music, just as language, to be a "legitimate, complex, biological adaptation" of our species and argues that, as such, it "can evolve only through natural selection or sexual selection" (p. 334). He identifies nine adaptationist criteria and notes that music fulfills many classic criteria for being a complex biological adaptation in the human species. He observes that most animal signaling systems are considered adaptations that manipulate the signal receiver's behavior to the signaler's benefit and contends that music also may be analyzed as a biological signal that manipulates receivers to the benefit of signalers. He maintains that music is a complex adaptation that, while having no clear survival benefits, evolved because of its reproductive benefits and therefore, in a manner analogous to some animal courtship signals, is "most likely an outcome of mate choice" (p. 337). He thus concludes that Darwin's courtship hypothesis, especially when considered in light of contemporary evolutionary psychology, biological signaling theory, and sexual selection theory, remains a plausible hypothesis regarding music's origins (p. 330).

Despite his advocacy of the sexual selection theory, Miller recognizes that much music making is done in and for groups, which presents somewhat of a quandary for courtship theory that seemingly benefits individuals rather than groups. He observes, however, that group benefits may reinforce individual benefits or that the "experience of producing music in a large group may feel good simply for mood-calibration purposes" (p. 353).

Merker (2000) also recognizes that music's evolutionary origins involved

group activity, but he suggests that *synchronous chorusing* may have played the important role. He notes that most musics employ an underlying pulse that is "a cardinal device for coordinating the behavior of several individuals in a joint, coherent, synchronized performance" (p. 316) and suggests that our earliest hominid ancestors' abilities to *entrain* themselves to move or respond to such a pulse allowed them to engage in synchronous vocal singing for mate attraction. Such synchronous calling, he contends, "would maximize the summed amplitude of the multivoice display to extend its geographic reach beyond territorial boundaries" (p. 318). He considers this to be true cooperative synchronous calling that a group of males might find useful in attracting groups of migrating females who were from beyond their territorial boundaries. He argues that this ancestral adaptation for entrainment of a repetitive beat supplies "an ancient biological foundation for the musical pulse no human culture has failed to feature among its musical means of expression" and, ultimately, "an irreducible biological root of human music" (p. 319).

Merker goes on to suggest that such synchronous chorusing involved vocal learning which would require increased auditory reception and vocal production development, and thus facilitate expansion of cortical development. He raises the possibility that language for referential purposes might have been a fairly recent development and that we may have been singing and dancing hominids before we became talking humans (p. 323).

Other writers also have offered sociobiologically-based views of music's origins. Blacking (1973) argues persuasively that "we shall learn more about music and human musicality if we look for rules of musical behavior which are biologically, as well as culturally, conditioned and species-specific" (p. 100). Gaston (1968, pp. 7–17) and Sloboda (1985, pp. 241–268) concur. Such a view suggests a certain evolutionary basis for music's origins, but in a much different sense than the mating call notion.

Gaston argues that the beginnings of human society go hand in hand with human biological development, and stresses that biological and cultural evolutions were part of the same process. He notes that with the development of the brain's cortex, primitive people could suppress rage and hostility, a prerequisite for society's development. Cortical development freed the primitive female from blind instinctive behavior that would cause her to accept just any male at each period of estrus. The cortical became dominant over the endocrine factor.

These two aspects of biological development, suppression of rage and selective mating, fostered *the beginnings of family*, with its resulting division of labor, modified male-female aggression, and increased communication. "All this leads to a uniqueness in humans, among all animals, of the mother-child relationship, without which there would be no culture as we know it"

(Gaston, p. 11). Human infants' almost total dependence on their mothers for a long period of time required mothers to devote much time to infant care, while the fathers in primitive hunter-gatherer societies provided food and protection. Gaston speculates that as the primitive mother sought to soothe her child and express feelings for it, her soothing efforts assumed the rhythmic character of lullabies, and that such lullabies may have been one of the earliest musical forms.

In a more contemporary development of Gaston's view, Dissanayake (2000) believes that "it is in the evolution of affiliative interactions between mothers and infants–not male competition or adult courtship–that we can discover the origins of the competencies and sensitivities that gave rise to human music" (p. 389). Essentially suggesting a *mother-infant interaction theory*, Dissanayake contends that such interactions involved much more than lullabies. Rather, they included a wide array of temporally patterned movements, including "ritualized packages of sequential behaviors, vocal, facial, and kinesic," that have the capacity to *"coordinate the emotions of participants and thus promote conjoinment"* (p. 390).

Dissanayake notes that early mother-infant interactions provide many psychological and sociocultural benefits beyond physical protection and care and suggests that many such interactions contain potentially musical elements. For example, the prosody of "motherese" is melodic and includes rhythmic regularity and variety, dynamic variation, tempo changes, and alterations of vocal timbre. While the mothers may use words, the infants presumably hear the combinations of sounds with particular features and relationships that one may consider musical (p. 394). Dissanayake also describes several other important and somewhat less obvious similarities between music and mother-infant interaction:

> Their use of sequential structural features that rely on expectation to create emotional meaning; the importance in both of crossmodal neural processing, using kinesic and visual as well as vocal channels; the importance to both of physical movement; and the achievement in both of social regulation and emotional bonding. (p. 394)

Dissanayake provides analogies showing the importance and role of expectancies and the effect of disruptions or delays of expectancies in generating or heightening affect both in response to music and in infant response in a dyadic situation. She suggests that infants may perceive similar feelings from cross-modal stimulation (acoustic, visual, tactual, kinesthetic) and that they may have the ability to perceive such supramodal features of experience as intensity, contour, rhythm, and duration analogically. She suggests that music and movement were inseparable in their origins and that they remain

integrally related in musical behavior today. And, she notes that both mother-infant interactions and music making in premodern societies are shared endeavors wherein conjoinment, coordination, and unification are integral aspects of the experience (pp. 394–398).

Finally, Dissanayake suggests that the mother-infant interactions, with their patterns of multimodally presented temporal sequences of emotionally evocative behaviors, provide the beginnings for human response to the temporal arts of dance, mime, chant, and song. As she states,

> the biologically endowed sensitivities and competencies of mother-infant interaction were found by evolving human groups to be emotionally affecting and functionally effective when used and when further shaped and elaborated in culturally created ceremonial rituals where they serve a similar purpose–to attune or synchronize, emotionally conjoin, and enculturate the participants. (p. 401)

Regardless of how convincing any of the above theories may be, music clearly was a very important part of early human society and culture. The views of Sloboda (1985, pp. 265–268), Dowling and Harwood (1986, pp. 235–238), and Brown (2000, pp. 296–297), discussed above, make a strong case that music was an invaluable tool in facilitating group adaptation, including promoting group identification, group cohesion, and social bonding. Implicit, if not stated directly, in each theory is the notion that music is a powerful force in facilitating positive interpersonal interactions, whether between potential mates, mother and infant, or within groups in a broader social or cultural setting. As Hargreaves and North (1999, p. 75) note, virtually all of Merriam's functions are really social in nature. Kaplan also considers music's most important functions to be social functions, and most of Gaston's functions for the individual have to do with facilitating an individual's interpersonal skills–also social functions. All this suggests that any consideration of music's origins must recognize at least in part its value *as an adaptive social force,* which in itself may have provided sufficient *raison d'être* for music's origins.

Music, Universals, Society, and Culture

Whatever music's origins, music is human behavior that occurs within a cultural context. Through an enculturation process, each social order develops its institutions and artifacts for perpetuation of itself, and music's existence is one of the few things common to all cultures (Nettl, 1975, p. 71). More recently, Nettl (2000, p. 468) summarized what he considers four universal uses of music: It is used (a) in rituals of all known societies, (b) to provide "some kind of fundamental change in an individual's consciousness or in the ambiance of a gathering," (c) to mark the importance of an event, and (d) virtually universally in association with dance, although dance does not accompany all music, and music does not accompany all dance.

In much of European and American society, a curious paradox exists: Music is readily available, yet that very availability may make many people take music for granted. Music is a type of commodity, for use at the pleasure of the consumer. Perhaps this results from a dichomitization of society into a relatively small group of music makers and a relatively large group of music listeners, many of whom listen passively rather than actively. Despite music's importance to people, many people may not readily recognize its importance.

Music serves some common functions in most societies, even though musical styles and forms vary among cultures. Through its functionality, music is an integral cultural component, serving as both a cohesive and perpetuating force. Music also reflects cultural values and temperaments. Weber's (1958, p. xxvi) analysis of music's rational and social foundations even suggests that the difference between Western music and that of other (particularly Eastern) cultures is rooted in Western people's temperament and their drives to rationalize and understand environmental phenomena. Nettl (1975, p. 93) agrees that a society's character and quality of life greatly influence its music, but he notes that other factors, e.g., technological level, types of raw materials available for instrument construction, amount of contact with other cultures, and attitudes toward cultural change or continuity, also influence the development of a culture's music.

Recognition of cross-cultural "universals," noted in the above citations of Arom (2000), Carterette and Kendall (1999), Richman (2000), Roederer (1995), and Sloboda (1995), does not negate the fact that sociocultural content influences musical behavior. While music obviously must exist within physical and physiological parameters, and has some structural similarities and serves similar functions in different cultures, individual musical behaviors vary greatly from culture to culture. Explaining intercultural variations is difficult; Sloboda (1985, pp. 244–248) makes a strong case for the use of notation as an explanatory variable, especially regarding differences between oral and literate cultures. In an oral culture, learning is bound inextricably to fundamental human interactions; individuals gain knowledge through custom and ritual. In literate societies, knowledge is not limited to memories of oral discourse and first-hand experience; symbol systems, such as notation, allow storage of knowledge. That storage allows recreation of prior knowledge with aid of symbols, but it also puts a certain psychological distance between an individual and the accumulated knowledge of the culture that created the symbol system. Furthermore, individuals may be selective regarding aspects of knowledge and more objective in examining that knowl-

edge than individuals operating in an oral culture tradition, where learning and knowledge are more of an integral part of one's self.

Sloboda notes that differences between directly recalled and symbolized knowledge may affect musical traditions and behaviors in the two types of cultures. In oral cultures, music, like verbal knowledge, mutates over time: Relatively exact knowledge of particular pieces of music that people might gain through repeated examination of scores and listening to recordings (a way of preserving sound, considered an extension of notation) is virtually impossible. Sloboda suggests several implications of oral/literate differences for musical behavior: (a) memory processing strategies and structures of individuals in the two cultures will differ, (b) the "architectural" complexity of an oral culture's music necessarily will be limited, (c) the nature of a literate culture's musical *content* may be examined separately from musical *context,* and (d) notation leads to *selecting* some aspects of sounds for preservation and discarding others.

Culture clearly affects musical behavior. Conversely, music may influence the culture. Lomax (1968, p. 133) summarized music's cultural role by suggesting that music is a human vehicle for expressing what is most basic in intersocial relationships. Lomax's examination of music in different cultural settings revealed that a culture's favorite music "reflects and reinforces the kinds of behavior essential to its main subsistence efforts and to its central and controlling institution" (p. 133).

Research and writings conducted over several decades (Bindas, 1992; Blacking, 1973; Cross, 2001; Frith, 1988; Hamm, Nettl, & Byrnside, 1975; Hargreaves & North, 1997, 1999; Kaplan, 1990; Lomax, 1968; Merriam, 1964; Nettl, 1956, 1975; Wallin, Merker, & Brown, 2000) continually support the hypothesis that music is an integral part of culture. Two once "classic" psychology of music texts (Farnsworth, 1969; Lundin, 1967) were premised on the view that music is a cultural and social phenomenon. Hargreaves and North's (1997) recent volume, *The Social Psychology of Music,* reinforces music's position as a sociocultural phenomenon.

The growth of music sociology, psychomusicology, ethnomusicology, anthropology of music, and, especially, the recent emergence of evolutionary musicology as a discrete field of study further attest to musical behavior as an integral component of human society and culture. Students of musical behavior, therefore, must be cognizant of the context in which such behavior occurs.

Summary

1. This chapter's content relates closely to two fields of study, *comparative musicology,* which examines music's functions and uses in all human cultures, and *evolutionary musicology,* which involves exploration of music's evolutionary origins.
2. Music is a phenomenon of humankind, created by and for people, and is present in all cultures.
3. Merriam's 10 anthropological functions of music include (a) emotional expression, (b) aesthetic enjoyment, (c) entertainment, (d) communication, (e) symbolic representation, (f) physical response, (g) enforcing conformity to social norms, (h) validation of social institutions and religious rituals, (i) contributions to the continuity and stability of culture, and (j) contributions to the integration of society.
4. Kaplan's sociological functions include art [read *music*] as (a) a form of knowledge; (b) collective possession; (c) personal experience; (d) therapy; (e) moral and symbolic force; (f) incidental commodity; (g) symbolic indicator of change; and (h) link among the past, present, and scenarios of the future.
5. Frith identifies four functions of popular music: (a) to create a type of self-definition; (b) to provide a way of managing the relationship between one's private and public emotional lives; (c) to shape popular memory, organize one's sense of time, and intensify a given experience; and (d) to provide a sense of musical *ownership.*
6. Hargreaves and North summarize music's social functions in everyday life for the *individual,* noting that they are manifested in three basic ways, facilitating the management of *self-identity, interpersonal relations,* and *mood.*
7. Gaston's eight considerations of music for the individual include (a) the need for aesthetic expression and experience, (b) the influence of the cultural matrix on the mode of expression, (c) the integral relationship between music and religion, (d) music as communication, (e) music as structured reality, (f) music's relationship to the tender emotions, (g) music as a source of gratification, and (h) the potency of music in a group.
8. Virtually all functions and uses of music include a social dimension.
9. There is increasing recognition that music's importance in society and culture depends in part on human biological evolution that made possible adaptive behaviors such as language and music.
10. Music of all cultures involves organizing sounds with varying pitches, loudness levels, and timbral qualities within a rhythmic framework organized around an underlying pulse or beat that facilitates perception and group participation.
11. The use of fixed pitches is virtually universal, and most musical scales contain a relatively small number of pitches (usually five to seven per octave) of unequal sized intervals.
12. Sounds are music when they are created or combined by a human being,

recognized as music by some group of people, and serve some function for people.

13. Most myths and legends regarding music's origins suggest that some supernatural being gave music to people.
14. Some late nineteenth- and early twentieth-century theories regarding music's origins include the (a) Darwinian theory, (b) theory of rhythm, (c) work song theory, (d) theory of imitation, (e) theory of expression, (f) theory of melodic speech, (g) communication theory, and (h) theory of an undifferentiated method of primitive communication.
15. The emergence of evolutionary musicology has given rise to revisions and expansions of some early theories as well as to the development of some new theories.
16. Contemporary theories of music's origins include (a) Brown's *musilanguage theory;* (b) Miller's updated account of the *sexual selection theory,* (c) Merker's *synchronous chorusing theory;* (d) Dissanayake's *mother-infant interaction theory,* which in many respects is similar to Gaston's (1968) *beginnings of family theory;* and (e) a theory of *music as an adaptive social force.*
17. Whether an oral or a literate culture, a culture's characteristics affect the culture's music.
18. Music reflects a culture's values, attitudes, and temperament.

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Chapter 3

FUNCTIONAL APPLICATIONS OF MUSIC IN CONTEMPORARY LIFE

As noted in Chapter 2, music has served and still serves many basic functions in society. Music is an important human endeavor that is integral to all cultures. Besides aesthetic and expressive functions, music serves many nonmusical functions.

> Indeed most music is performed for the express purpose of achieving aims wherein the aesthetic is not the primary goal. The *functional music* is far older and more abundant than music played or composed for aesthetic purposes. All primitive music is functional music . . . [and] a majority of the reasons given for school music ascribe to its functional goals. (Gaston, 1951/52, p. 60)

While Chapter 2 discussed music's general functions, the present chapter examines music's functional applications in contemporary life. Hargreaves and North (1999) maintain that examination of the functions of music in everyday life should be an integral part of music psychology.

Hodges and Haack (1996, p. 497) note that music touches people in contemporary life along three continua: (a) from birth to death, (b) from lowest to highest levels of cognitive functioning, and (c) as individuals through large social groups. Furthermore, they point out that people experience music in a wide range of settings beyond the concert hall: in the home, at school, in the community, in the marketplace, in religious services, as part of many special occasions, in politics, in the military, in health care systems, in association with widely varying physical activities, in commercial media, through professional and social organizations, as an occupation, as part of public environments, as well as in many other social and commercial contexts (pp. 498–501).

Brown, Merker, and Wallin (2000, p. 12) emphasize that contemporary uses of music need not bear one-to-one correspondence to its functions and uses from earlier times and note that music's multifunctional nature reflects the actions of many selection pressures. Some of the discussed uses are traditional; i.e., they are similar to music's uses throughout much of the history of Western civilization: in religious rites and ceremonies, to promote social

conformity and interaction, to accompany dance, and generally to contribute toward cultural continuity and stability. Other uses are directed more specifically toward particular industrial, commercial, therapeutic, and educational ends.

People long have recognized that different types of music serve different purposes and that many factors serve to influence each person's musical behavior. Nevertheless, the purpose of much functional music is to stimulate or suppress activity, and a brief discussion of some of music's structural characteristics that enable it to stimulate or suppress seems warranted. The reader should recognize that an individual's previous experiences with particular musical structures also influence his or her responses to those structural characteristics. Within a given cultural context, people learn to react in certain ways to certain types of music. While the exact nature of the interaction between learning and the structural characteristics is not clear, observations of reactions to the two basic types of music suggest that differential response patterns are real, regardless of the degree of influence coming from learning or from the structural characteristics themselves.

Stimulative and Sedative Music

All music exists on a continuum between highly stimulating, invigorating music and soothing, sedating music (Gaston, 1968b, p. 18). McMullen's (1982) theoretical model of the dimensions underlying music meaning suggests that *energy* and *structure* in music are experienced as forms of *activation* or *arousal*.[1] For McMullen (1996, pp. 391–393), activation may involve a "heightened state of arousal, either psychological, physiological, or behavioral."

Music therapists and others using music to influence behavior essentially are concerned with arousing or suppressing activity, and the type of music selected for influencing the desired behaviors generally reflects different structural characteristics, particularly regarding energy.

Stimulative Music

Music that stimulates or arouses listeners has a strong energizing component. "For most people it is rhythm that provides the energy of music, be it great or small" (Gaston, 1968b, p. 17). Lundin (1967, p. 172) and Farnsworth (1969, p. 83) both suggest that tempo is of primary importance in influencing mood and activity response to music.

[1] *Arousal potential* of music is a central concept of Berlyne's (1971) "experimental aesthetics," and an underlying premise is that music's structural characteristics, particularly complexity and tempo, influence one's responses to music (North & Hargreaves, 1997, p. 275). Arousal potential as part of Berlyne's experimental aesthetics is discussed in Chapter 8.

Rhythm characterized by detached percussive sounds tends to stimulate muscular activity. March and dance music usually has definitive and repetitive rhythms that appear to stimulate physical movement. The more percussive, staccato, and accented the music, the greater the apparent physical response to it. Whenever the underlying beat is clearly defined, even a casual listener is likely to respond with some overt physical response.

While rhythm, and particularly tempo, appears to be the dominant energizing factor, dynamic level also may stimulate. Louder music generally stimulates greater physical response than softer music. Other musical attributes, such as pitch level, melody, harmony, texture, and timbre, also may help energize music, but the extent to which these variables contribute toward music's driving, energizing force is less clearly understood than for rhythm and dynamics.

Sedative Music

Music that soothes, calms, or tranquilizes behavior appears to rely on nonpercussive and legato sounds. Its melodic passages usually are sustained and legato, and generally have minimal rhythmic activity. Sedative music's most important rhythmic attribute is an underlying beat, which usually is monotonously regular but subdued. Lullabies are a prime example of functional sedative music. They contain sustained legato melodies, with a quiet but steady underlying beat. Lullabies usually are quite soft, much slower than stimulative music, and quite limited in frequency range.

Differential Responses to Stimulative and Sedative Music

Individuals concerned with using music for functional purposes long have recognized the differential response to the two types of music, but they have not gone to great lengths to corroborate the effects through research.[2] Certainly, music used by the military throughout history to incite troops into battle reflects the characteristics of stimulative music, as does music of today's school pep and marching bands. On the other hand, melodies used to soothe infants reflect characteristics of sedative music. March music reflects different characteristics than romantic music. Responses to adjective checklists, taken as indicators of mood or character response to music, reveal quite different lists of adjectives for stimulative and sedative music. Applause at concerts generally is much greater for stimulative than for sedative music.

Much of the limited research particularly focused on comparing responses to the two types of music was conducted in the 1940s and 1950s at The

[2]An exception to this might be some of the research conducted by consultants for the Muzak™ Corporation, discussed later in the chapter.

University of Kansas by some of Gaston's students. His (1951/52, 1968b, pp. 18–19) reviews of this research revealed that nearly all studies found significant differences in response to stimulative and sedative music. Judges readily classified drawings and paintings by both children and adults according to which type of music the artists heard while creating. Studies of postural response revealed that subjects sat more erect when listening to stimulative music than when listening to sedative music. Clinical observation of sedative music's effects on patients in a hospital ward revealed an observable sedative effect for the ward as a whole.

Two comprehensive reviews of research on physiological response to music also provide evidence that stimulative and sedative music elicit different effects. Hodges' (1980) review generally revealed differential response to stimulative and sedative music, although inconsistencies existed among the results of the various studies. Bartlett's (1996) more recent review revealed that data for 62 percent of 190 hypotheses tested in the various studies "demonstrated results that seemed to correspond with intended outcomes" (p. 375). Characteristically stimulative music tended to increase physiological rates (e.g., heart rate), while characteristically sedative music tended to have soothing or relaxing effects (e.g., decreased muscle tension).

Boyle's (1982) study of 145 university students' verbal descriptions of excerpts of stimulative and sedative music provided additional evidence of differential response to the two types. Subjects responded to each of six excerpts, three stimulative and three sedative, on a five-point continuum between each of the following bipolar adjective pairs: happy/sad, restless/calm, joyous/gloomy, whimsical/serious, vigorous/quiet, majestic/soothing, playful/dignified, and exhilarated/dreamy. (Each adjective pair appears in opposite clusters of the Hevner Adjective Circle, appearing in Chapter 8.) The mean difference in ratings for the two types of music for each pair of adjectives was highly significant ($p < .001$). Such data support the theory that affective response to music is related to the activation and energizing characteristics of the musical stimulus. Mood response, which seems to reflect a "disposition to action," apparently is intertwined somehow with response to stimulative and sedative music. Music therapists and Muzak-like corporations undoubtedly will continue to exploit music's activation characteristics to influence human behavior.

In a recent study of a different nature, Nittono, Tsuda, Akai, and Nakajima (2000) reported that college undergraduate students engaged in a self-paced tracing task performed the task much more quickly when provided with background music with fast tempi than when provided with background music with slower tempi. Numerous marketing studies, discussed below, yielded similar results: Faster background music resulted in customers moving more quickly through a commercial establishment than did slower back-

ground music.

Despite some inconsistent results from physiological research, strong evidence from various perspectives supports the contention that people respond differently to stimulative and sedative music. The evidence includes examples of music throughout history, musical examples in contemporary daily life, and a limited number and variety of research studies. Discussion of various applications of this knowledge and the subtlety with which it is applied for particular uses comprises much of the balance of this chapter. Some applications capitalize on music's ability to stimulate; others capitalize on its ability to soothe. These applications are discussed as they pertain to music in ceremonies; background music; commercial, industrial, and therapeutic uses of music; music to facilitate nonmusical learning; and music as a reward for changing behavior.

Music in Ceremonies

Ceremonial music reflects one of music's earliest functional uses, a use that has continued throughout history and remains an important part of most ceremonies today. Commemorative ceremonies not only remind one of past events or beliefs; they represent an experience or a myth to people who did not live the original experience (Connerton, 1989, p. 43). Music is viewed as an integral part of ceremony and does much to enhance the formality of such occasions. Virtually all types of ceremony, be they religious, military, state, athletic, or commercial, incorporate music in some way.

Mussulman (1974, p. 129) notes that music has functioned more consistently and positively in religious ritual than in any other area of life in Western civilization, even to the extent that religious music comprises one of Western music's longest and richest traditions. Sullivan (1997) relates that over the centuries, people have attempted to hold music fundamental to the creation of the universe and humanity's place within it.

Music's specific function in ceremonial worship tends to vary with its place in the ceremony. Within Christianity, particular music is designated for the formal sections of the Roman Catholic mass and the main Anglican services, as well as formal Lutheran services. Much Jewish worship practice makes extensive use of liturgy. In both Christian and Jewish practice, liturgical traditions continually evolve, sometimes slowly, sometimes suddenly by authoritative fiat (Walton, 1992; Winter, 1992).

Christian churches of a more evangelical tradition, such as the Methodist, Baptist, and Presbyterian denominations, also include music as part of the services, but since they generally place less emphasis on observance of corporate sacraments, the music generally functions more as a congregational celebration and corporate observance than as a prescribed ritualistic obser-

vance. Hymn singing, an important part of these services as well as many Anglican and Lutheran services, is a direct way to involve the congregation in the service.

The use of music in Islam is significant, albeit controversial and varying in practice among Islamic cultures. Technically, the chant-like musical sound in Islamic religious practice is not "music" (Nasr, 1997, p. 220; Quresi, 1997, p. 264). While the sound of the Qur'an's holy words has importance beyond the meaning itself, it is not intended to be music. Shiloah (1995) notes that the Qur'an does not mention music explicitly, and legal and theological authorities have disagreed regarding what is admissible. As with other religious traditions, leading worshippers astray through sensuous sounds is considered dangerous; art music, where music itself is the primary concern, is especially bad because it displays human vanity and worldly concerns. Folk "music" that supports the holy words and enhances their meaning is not music per se, and therefore is permissible. Shiloah (1995, p. 37) indicates that the most effective Islamic worship "music" avoids rhythmic regularity and is subordinate to the flow of the text. While the sounds may feature various embellishments beyond strictly spoken text, they must flow from the content of the text. The practice of *tadjwid* evolved as a system of regulating embellishments in accordance with proper phonetics, diction, and rendition of the sacred words.

Music in religious services serves several additional functions. At times, it serves as a signal to stimulate the congregation to respond in a certain way; at other times quiet organ or choral interludes are used to help establish a mood of reverence or tranquility. While congregational singing serves to draw people together in active participation, choir anthems may lead the worshipers to reflect on the religion's beliefs and values and implications for themselves as individuals. Special music accompanies special religious ceremonies. Certainly weddings, funerals, and special religious holidays are made more meaningful by music designed to enhance the occasions' significance. Some uses of music in religious ceremony, however, are more "persuasive" than "ceremonial," attesting further to music's importance to religion.

Perris' (1985, pp. 123–135) examination of music in major world religions focuses particularly on music's persuasive function:

> Music in all worship is expected to heighten the desired emotional effect in the listener, to emphasize the ritual text, especially certain significant words, and to focus the worshipper's attention on the rite. But the danger of so sensuous a phenomenon as music is that it may be more seductive than the rite itself, and that the musicians may evoke more interest than the priests. If the music in the worship service is "entertaining," is the religious ambience destroyed? How can the worshipper's attention be shielded from wandering? (Perris, 1985, p. 124)

Perris' juxtaposition of concepts from four major world religions–Judaism, Christianity, Islam, and Hinduism–revealed that, even though some obvious differences exist in the way the four religions use music, six underlying factors require consideration when using music in religious service: (a) the words must be comprehensible to the congregation; (b) traditional melody and performance practice should be observed; (c) the use of any musical instruments must be morally and socially acceptable; (d) music must be used for proper purposes and at proper places in the worship ceremony; (e) music in a worship ceremony should not be misused, i.e., detract from the ceremony's purpose; and (f) composers' artistic goals should not override theological concerns. Perris notes that this final consideration is a particular concern of Western religious music.

Related to artistic-theological conflicts is the way important musical works with origins in religious functions have become part of the concert repertoire, especially in Western classical music. The Bloch *Sacred Service* is based in Jewish liturgy. The masses of Verdi, Mozart, and Beethoven, oratorios such as Handel's *Messiah* and Haydn's *Creation,* and the wealth of Bach cantatas and chorales come from Christian settings. More questionably, people may find aesthetic pleasure in listening to rhythmic chanting intended for native American religious ceremonies or in the sound of the *'alim* calling the Islamic faithful to prayer. Bohlman (1997) notes that music which originated from local practice may acquire an international audience, become entertainment, and then belong to musical consumers more so than to the religious practitioners from whom the music evolved.

While music in religious ceremony may serve more than "ceremonial" functions per se, other functions do not negate its importance in heightening the meaning and impact of the ceremony, and music most likely will continue to serve a major role in religious ceremonies throughout the world. Perhaps composers' artistic concerns, which may undermine music's persuasive value, ultimately may enhance its ceremonial value.

Music also has been a traditional part of military and state ceremonies, where, as in religious ceremonies, it has served various functions. Military music's traditional functions have been to inspire and heighten interest in the military cause and to stimulate troops to battle. Signalling functions were of major importance prior to the development of the telegraph, field telephone, and radio; many military traditions involving "signals" such as "call to the colors," "reveille," and "taps" continue. That music for the military traditionally has been band music characterized by percussion and fanfare is more than coincidental. Such music usually has a highly stimulative effect. Even today, most nations' military and state ceremonies include music of the military band rather than string instruments.

In recounting the history of the use of music in the British army, Winstock

(1970) notes that songs *about* war are not necessarily the songs *of* war, i.e., songs of the soldiers themselves. While many alleged instances of bands or other organizations inspiring the troops exist, music also includes cynical parodies of military life. His or Her Majesty's armed troops historically needed less of a musical inspiration and more of a musical solace. In Winstock's words,

> the soldier needs "stirring" songs less than anyone else. Such songs provide the civilian with a vicarious outlet for physical involvement in war, but the soldier, conversely, has committed himself to face the ultimate danger and needs no substitutes. For him music can be part of war–but it can also be a relief from the starker realities of the conflict. The soldier has no intense need to assault the enemy by word of mouth–for he has more lethal weapons. Where his songs are "war songs" in the literal sense–bellicose and breathing fire–they owe their appeal less to the ardour they express than to the circumstances of their composition. (p. 277)

Arnold (1993) traces the depiction of war in music, particularly art music, and notes differences in the character of the music. War-related compositions, largely depicting battles, were common prior to the twentieth century, but these rarely are performed today. Twentieth-century composers seldom praised war. The ancient Greeks used music to portray war, as well as to maintain military order, arouse the troops, and signal attacks; the Romans may have copied the Greeks. During medieval times, while art tended to stress triumphant aspects of war, composers did not try to portray battles realistically, as later composers did. In the Renaissance, when armies often employed drummers, compositions portraying war stressed rhythm rather than harmony. During the Baroque era, music, as well as literature and painting, tended to stress the "glories" of war. The late eighteenth and early nineteenth centuries saw the introduction of national and military songs into art music; Beethoven's *Wellington's Victory* is a prominent example. Later in the nineteenth century, music was less likely to depict contemporary wars. Interestingly, with the development of more rapid communication and photography, truer pictures of battlefield carnage emerged, thereby making audiences more cynical toward glorious depictions of battle.

Music in military and state ceremony is used not only as a signal to draw attention to a particular part of the ceremony, such as playing "Hail to the Chief" to signal the arrival of the President of the United States, but, as apparent in times following the September 11, 2001 World Trade Center/Pentagon tragedy, it also is used to create a unifying feeling of patriotism. At other times, it is used to commemorate specific important occasions. In short, music serves to heighten an occasion's immediate importance as well as contribute toward its memorableness.

Attali (1985, p. 19) views music as a tool of state power because it can be used ritualistically to make people forget general dissatisfactions, believe in a harmonious world, and become oblivious to competing sounds. He says (p. 19), "Make people Forget, make them Believe. Silence them." While Attali's views may be somewhat radical, music certainly has been an important aspect of totalitarian societies.

Many occasions other than religious and military include ceremonial music. Sporting events are a prime example. The opening and closing ceremonies of the Summer and Winter Olympic Games always involve special music, and the medal ceremonies include playing the national anthems of the gold medal recipients' countries. High school, college, and professional sports events open with ceremonial music, often including the national anthem and team or school songs. Music of marching and pep bands, while not always ceremonial per se, often serves an important function for sporting events.

Nearly any queen (or king) crowning ceremony, whether a high school homecoming event or a Miss World (or America, or Universe, or Strawberry Festival) beauty pageant incorporates music. The coronation of a "real" queen or king as head of state features music. Folk festivals, while perhaps not ceremony in the ritualistic sense, usually rely on music as an integrative force as well as heightening the memorableness of the occasion.

From this cursory review, it is apparent that music is an important part of most ceremonies. While research has not examined ceremonial music's effects from a "scientific" perspective, the fact that music has been and continues to be a part of most ceremonies attests to its functional value in enhancing the importance and memorableness of many occasions.

Commercial Music

"Commercial" uses of music refer to using music in some way to make money from music directly or to enhance business through the use of music. North and Hargreaves (1997, p. 268) suggest that commercial uses of music "constitute one of the principal sources of our exposure to music in the Western world." The next few sections examine commercial uses of music from several perspectives: background music, music in advertising, music as entertainment, and music for narration, especially as a way of enhancing a story told in another medium.

Background Music

Music has been a "background" for various activities for centuries. The development of electronic recording and reproduction systems enabled background music to become highly prevalent in society, whether as a part of a planned audio environment or as the result of happenstance.

The term often connotes some type of "mood music," "easy listening," or "beautiful music," although almost any type of music may serve as a background for something else. Mussulman (1974, p. 93) notes that background music is "intended to be heard but not actively or purposely listened to." Strictly speaking, music that captures a person's attention is failing to function as truly "background" music. Models and theories incorporating deliberate attention as essential to an aesthetic experience with music or to determining musical preference (see Chapters 8 and 9) theoretically do not apply to background music.

An unresolved question regarding background music concerns loudness level. The intent of background music is to be unobtrusive yet sufficiently loud to have some desired effect on the "listener." That all listeners will not desire the same loudness level is a given, but when it becomes sufficiently loud that it becomes obtrusive, it may no longer be considered background music. Studying the effects of loudness level on 144 college students' relaxation responses, Staum and Brotons (2000) found an overwhelming preference for soft music. The authors suspect that most people prefer soft background music, although what is considered "soft" will vary greatly among individuals.

The term "new age" occasionally is applied to some background music. Usually, new age music is instrumental, often featuring solo piano or guitar, quasi-chamber ensembles, synthesizers, or a mix of electronic and acoustic instruments. Describing the style, Pareles (1987, p. 3C) indicates that "almost invariably the tempos are slow, the harmonies simple, the timbres rich, and the recording quality full-bodied and noiseless" because "it eliminates the most complex, time-consuming, mentally draining part of the musical experience: paying attention." Time may resolve the question of whether new age music is really a style or an alternative label for background music; certainly, it lends itself well to background functions.[3]

Another generic label for background music is "Muzak™." While Muzak, under its various corporate owners, is indeed the best known provider of background music in the workplace, the Minnesota Mining and Manufacturing Company and Audio Environments Inc. have provided significant services; other regional and local vendors exist. Yet, the Muzak label often is attached to any form of relatively unobtrusive music, just as a facial tissue often is called a "Kleenex™," regardless of its actual manufacturer.

MUZAK'S DEVELOPMENT. The history of the Muzak Corporation and its social functions is important to the present discussion, and the authors have

[3]New age music has some similarities with "minimalist" music, which has been defined as "Vamp 'til ready, and nobody's ready" (G. N. Heller, personal communication, March 18, 2002). The "go nowhere" aspects of such music facilitate the background music function.

relied heavily on Husch's (1984) landmark historical study. Major General Squier, an officer in the U. S. Army Signal Corps during World War I, developed an idea for "wired" radio, a system in which radio signals would travel over electric power lines rather than through electromagnetic disturbances in the atmosphere and beyond ("wireless" radio). General Squier acquired a patent, which he sold in 1922 to The North American Company, a holding company that had created the General Electric Corporation and once financed the American entrepreneur and inventor, Thomas Edison. Shortly after, North American acquired Associated Music Publishers, Inc. as a source of a large music library, which the company could record and distribute via its background music subsidiary. The future Muzak thus was not a "garage business": It was a corporate enterprise from the beginning.

Initially called Wired Radio, Inc., the background music service was reorganized as The Muzak Corporation in 1934. The first transmissions were to homes in Cleveland, Ohio's Lakewood section, but Muzak soon began to concentrate on a type of "functional" music, sent over telephone lines to hotels and restaurants. A partnership purchased Muzak in 1938; by 1941, one partner, William Benton, became the sole proprietor. A vice president of The University of Chicago with a background in advertising, Benton had a significant influence on the development of Muzak into its modern form.

The Second World War saw continued growth in Muzak as its recording studios provided materials for the American armed forces and the defense industry. Important to Muzak's future, the war also saw a growing belief that providing background music for workers in offices and industry was beneficial to morale and boosted production. Much in-house literature that purported to document such benefits accrued.

By 1948, a characteristic format of 15-minute segments was in place. Unlike other providers of background music, Muzak uses the *stimulus progression* concept extensively. Over a 15-minute period, successive short musical excerpts increase in a *stimulus value*, which is based on the excerpt's tempo, accent patterns, instrumentation, and texture. The degree of progression varies; the corporation purportedly can match stimulus progression curves with worker fatigue curves: During the times of likely worker fatigue, such as the middle of a shift, the musical stimulation is high; during times of likely low fatigue, as at the beginning or near the end of a shift, the stimulation is relatively low. The 15-minute musical segments alternate with periods of silence.

Muzak passed through several owners and adopted ever more sophisticated programming. It made increasing use of industrial psychologists and medical professionals as consultants. Today, Muzak is available through the company's recorded tapes, as well as by direct satellite broadcast. While background music tailored to fit specific work situations remains the core business, Muzak also provides a type of "foreground" music, deliberately

programmed to capture the attention of potential customers (Hunter, 1983).

MUSIC IN THE WORKPLACE. In examining Muzak's operations, Husch concludes that five generalizations, based on early research, provide a rationale for its selection and use in the workplace: (a) Music generally is a successful way to combat boredom, (b) music in the workplace will increase productivity, (c) music will help improve employees' morale, (d) popular rhythmic music likely will be more effective than other types of music, and (e) proper scheduling is important for maximizing music's effectiveness.

Using music in the workplace to raise morale, coordinate efforts, or stimulate workers has a long history. During past years, diverse laborers, such as field hands, railroad track layers, sailors, and others, sang and chanted. The possibility exists for work songs wherever people work in groups and can hear each other. Yet, Muzak is a very different phenomenon, as Husch carefully describes.

A major difference between Muzak and earlier use of work songs is that the workers do not create Muzak while they work. Muzak imposes preselected music, usually as a result of a management decision. Rhythms and words do not arise from the particular task at hand, as they generally did in earlier work songs. Muzak's rhythms and implied words (Muzak usually has no audible words) have no necessary connection with the work at hand; workers' job-related physical actions are not a consideration in the music selection process.

Muzak thus has become another standard of operation in the manufacturing or service concern, similar to operations involved in word processing, accounting, or cleaning. It does not address any set of specific procedures or working conditions, and it is unrelated to any particular job site. Muzak has a regularity and predictability along with its mood variations. Rather than a focus on the immediate task, Muzak may encourage fantasy and reminiscence; many of the absent lyrics from Muzak song segments address love and friendship.[4] Husch goes so far as to suggest that Muzak is a form of auditory social control, which results in a control of symbolic action through alteration of time and space without human interaction. While Muzak is created separately from the people who must work in its presence, it affects an individual's state of mind as he or she works.

Whether Muzak or another source provides the background music, and whether it truly is a form of social control or merely a pleasant diversion, a logical question arises: Does it work? Muzak certainly has its success stories regarding increased productivity and enhancement of the workplace.

[4]Given the earlier definition of background music and the possibility that attention to the music may negate its purpose, one might argue that if the music abets fantasies and memories, it may no longer truly be background music. Indeed, this may suggest "referentialism" in aesthetics and art music (see Chapter 8).

According to Kerr (1945), several World War II era studies indicate that music tended to increase the amount of produced material meeting quality control standards. Music especially seemed to enhance productivity in highly repetitive work. A 1974 in-house Muzak brochure, with no author of record, claimed increased productivity and improved employee attitude in companies manufacturing electrical appliances and watches, an electrical utility, and a medical claim processing office. Wokoun (1979) found that Muzak apparently reduced fatigue among automobile workers, particularly during the afternoon.

Music may not always be the important variable in studies showing effects of background music in work settings. Many variables influence production and morale, both of which need clear indication of how they will be recognized in particular experimental settings ("operational" definitions). In relatively short-term studies, the Hawthorne effect, where increased personal attention results in a positive change in attitude or production, may be a factor. The type of work also is a consideration: Music actually may distract people engaged in relatively intellectual and nonrepetitive work. Realistically, some workers may not welcome background music, especially if other people select the music and determine the conditions under which it is heard.

Background music usually is conceived as a group experience, but modern personal headsets enable individual workers to select their own programming from available broadcasts or recorded music. While some supervisors may object to the "Walkman™ in the workplace"[5] phenomenon because it may remove people from the work environment excessively or interfere with necessary on-the-job communication, many workers engaging in repetitive work enjoy them (Powell, 1994).

Will background music enhance productivity, improve morale, and generally make a workplace more pleasant? The answer is a "definite maybe." No one reliably can guarantee that all workers will profit from background music, but unless the music is distracting or annoying, it is not harmful, and if people think that it is beneficial, for them, it probably is.

MUSIC IN THE MARKETPLACE. While the workplace is one major setting for background music, it also appears extensively in the *marketplace*. Its purpose essentially is to enhance customers' experience so that they will spend more money. In a restaurant, the music is intended to promote a pleasant dining atmosphere. In a store, background music presumably makes shopping a more enjoyable experience. In a television commercial, music presumably makes the advertised product or service more desirable. In all cases, the business's customers rather than its employees are the targeted "audience" for background music.

[5]"Walkman" actually is a model of personal radios and/or stereos, contained in headphones, manufactured by the Sony™ Corporation, but just as "Muzak" may refer to any background music, "Walkman" may refer to any personal headset.

Appropriate music may encourage people to spend more time (and money) in a particular store or restaurant. The music might add to a favorable ambience, people might like the particular music, the music might mask objectionable background sounds, or it might signal some favorable judgment to the customers. Experience suggests that stimulative music might elicit a faster pace and thereby move people through a store more rapidly or encourage them to eat faster. Conversely, sedative music might slow the pace through a store and encourage more browsing through the merchandise, and it might encourage diners to linger longer over food and drinks. Providers of background music would have to ensure that customers did not receive the music negatively.

To test the different effects of stimulative, sedative, and no music on shoppers' pace, sales, and customer reactions in a supermarket, Milliman (1982) alternated slow background music (MM ≤ 72, mean tempo $= 80$), fast background music (MM ≥ 94, mean tempo $= 108$), and no background music over a nine-week period. Results indicated that slow music indeed slowed the shoppers' pace: Respective mean observed times for passage between points for slow, no, and fast music were 127.53, 119.86, and 108.93 seconds; the slow and fast music times differed significantly. Gross sales were highest under slow music conditions and at their lowest under fast music conditions; the difference in sales under conditions of the two tempo extremes was statistically significant. Interviews revealed no significant differences among shoppers regarding awareness of the music conditions, regardless of the actual background music or lack thereof.

In a similar study, Milliman (1986) alternated slow and fast instrumental background music in an "up-scale" restaurant for eight successive weekends. On four weekends, Friday nights featured slow background music and the following Saturday nights featured fast background music. The alternate weekends reversed the music, i.e., Fridays featured fast background music. Results showed that customers spent significantly more time in the restaurant and spent significantly more on alcoholic beverages during slow music nights. The restaurant's gross receipts were significantly higher on slow music nights. Service time and the number of customers losing patience and leaving before they could be seated did not differ significantly between the two music conditions. The amount of food purchased did not differ significantly; apparently the restaurant's greater income on slow music nights was due to people lingering longer over more drinks.[6]

[6]Milliman's restaurant study was concerned with tempo, a very basic musical variable, and the music was *background* music. Restaurants must use care that the musical style complements rather than clashes with the restaurant's ambience. Loud rock music might be inappropriate in a restaurant attempting to present a sophisticated "up-scale" image. Sedative background music might be inappropriate in a Mexican, Italian, Greek, or other restaurant with an ethnic theme, where diners expect a broader cultural experience as well as a culinary experience.

In addition to regulating customers' paces and thereby enhancing the likelihood that they might spend more, music may enhance the marketplace by building a more positive attitude toward cooperative aspects of mutual selling and buying. Music therapists recognize that "pleasant" music may make an environment more attractive and clientele more receptive toward therapeutic uses of music and other therapies. Similarly, music may give people a more positive attitude toward cooperating with others. Fried and Berkowitz (1979) divided 80 university students (40 men, 40 women) into four groups. Three groups listened to music for approximately seven minutes; the remaining group "sat still" and heard no music. One listening group heard stimulative music, "One O'Clock Jump." Another listened to sedative music (which Fried and Berkowitz labelled as "soothing" music), two of Mendelssohn's "Songs Without Words." Coltrane's "Meditations" was played for the remaining group as "aversive" music. At the conclusion of their group's respective activities, subjects were asked to volunteer to help with another alleged experiment as a measure of helpfulness. The sedative and stimulative music created positive moods; the aversive music tended to arouse negative feelings. Subjects who previously heard sedative music were the most "helpful," with significantly greater helpfulness than the aversive music or no music subjects.

In a frequently cited (and often criticized) experimental study, Gorn (1982) paired otherwise similar beige and blue pens with liked music (from the then popular musical comedy *Grease*) and disliked music (Indian classical music). Beyond the .001 level of statistical significance, subjects tended to prefer the pen, regardless of its color, that was paired with the preferred music. In a second experiment, under a condition where subjects knew in advance that they eventually would receive their choice of pens, subjects saw the beige pen while they listened to liked music and saw the blue pen while they heard alleged product information (e.g., the blue pen would not smudge). This time, a majority (71%) preferred the blue pen; product information apparently overrode the favorable music association. However, in a similar experiment where other subjects did not know in advance that they would be asked to select a pen, a majority (63%) selected the *beige* pen. Gorn's study thus suggests that information has less impact in nondecision-making situations; perhaps music which can induce pleasant feelings or emotions is useful in "reaching" uninvolved potential customers. Although Gorn's pen research attracted considerable attention, Kellaris and Cox (1989) were unable to replicate the results and suggest that limited exposure to music is unlikely to influence product choice. Further research remains necessary.

North and Hargreaves (1997, pp. 274–276) note that music appears to serve two basic functions in the marketplace: arousal and pleasure. The

arousal function involves using music to mediate the tempo of consumer behavior, i.e., influence the pace at which customers move through a business establishment, while the pleasure function involves using music to mediate purchasing and affiliative behavior, thus making a store's environment "more pleasurable so that customers are more likely to demonstrate 'approach behaviors' toward it" (p. 275). The potential conflict between the two functions is obvious: Moving people too quickly through an establishment may undermine their potential purchasing behaviors.

Little question exists that music indeed may place potential customers or clients in a more positive mood, which in turn may make them more likely to purchase particular products or services. The general tendencies of slower music to make people linger longer and preferred music to encourage a more favorable response could be predicted from research in musical affect, musical preference, and music therapy. Of course, the operative verb is *may*—not *will*. A customer with a limited specific purpose in shopping and clear expectations regarding a desired product or service probably is less likely to be influenced by music or any other background condition, as compared with aspects such as quality of product or service, cost, and convenience. Furthermore, a shopping situation is highly complex, and many variables are involved.

Music in Advertising

Whether the potential consumer elects to enter a place where he or she may spend some money or is at home or somewhere else other than a store or service establishment, advertisers want to persuade that consumer to seek what they have to offer. In radio or television advertising, where the commercials may be quite incidental to the entertainment or information that the listener or viewer seeks, the use of music to attract and hold attention and induce a positive mood toward an advertised product or service is well-established. Indeed, music for radio and television commercial advertising has become a business in itself, even to the point where composers specialize in writing such music. Writing *jingles,* the music for broadcast commercials, has become "a billion-dollar-a-year industry that's growing all the time" (Shea, 1988, p. 49).

Commercials usually last between 15 and 20 seconds. Radio commercials may include both verbal and musical sounds; television commercials may add visual-verbal effects. In either case, the intent is to persuade the audience that the advertised product or service has value and help them remember it. Commercials usually are brief interruptions within some continuing program;[7] this may help attract attention (toddlers playing in a room with an

[7]Of course, programs ("infomercials") exist that are simply one long commercial.

operating television set often will interrupt their play in response to the change signaled by the onset of a commercial), or it simply may provide the audience with an opportunity to leave the room, read the newspaper, or otherwise ignore the broadcast.

Music may affect a person's mood, which is a relatively temporary state or frame of mind that individuals can recognize in themselves and describe verbally (Eagle, 1971, p. 19). Individuals may be in a happy, sad, depressed, pensive, optimistic, or pessimistic mood, or in other moods. Presumably a person in an appropriate mood state, whether due to music or to something else, may be more receptive toward a commercial and what it advertises than a person in an inappropriate mood state, whatever those states may be. The association of happiness with a product or service, such as a detergent, shampoo, or lawn maintenance service, that is intended to make life easier or more pleasurable certainly might increase interest in that product or service. A pensive or reflective mood might be especially desirable in a potential customer for life insurance or new tires. Gardner (1985) notes that mood states generally bias evaluation judgments in directions that logically relate to the mood. One may recall a favorable prior service encounter, such as a pleasant trip to a barber shop or beauty salon, in terms of some overall positive impression rather than in details of what happened to the hair. Interactions with a sales staff and the resulting mood may influence the customer's evaluation of his or her purchase, and a television program's content may influence persons watching the program.

Music may be a form of nonverbal communication, which clearly is important in advertising, regardless of an advertisement's verbal content. Stewart and Hecker (1988) include as nonverbal aspects the way something is said, facial expression, body movements and spacing, gesture, eye movements, touch, pictures, and symbolic artifacts (e.g., a judge's gavel in a commercial for legal services). The relative importance as compared with verbal information will vary, and context is especially important for understanding meaning of nonverbal information. Stewart and Hecker exemplify context by describing a woman slowly opening her lips to an approaching man. After a brief sensuous buildup, the "enticement" is revealed, not as part of a sexy novel, but as part of a commercial for a dental practice.

The importance of nonverbal information is supported further by Holbrook and Batra (1987), who identified six descriptive factors from adult women's judgments of 72 television commercials: emotional, threatening, mundane, sexy, cerebral, and personal relevance. They also identified pleasure, arousal, and domination as three dimensions of emotional response to commercials.

Alpert and Alpert (1989) describe the television audience as likely to contain viewers who are far more involved in the programs than in the commercials. As such, they are "potentially uninvolved nondecision making consumers rather than cognitively active problem solvers" (p. 487). Advertisers may hope to link favorable associations to the advertised products and services via emotionally arousing presentations of music, colors, lighting, or other nonverbal aspects. They may hope that music will influence viewers' moods favorably and thereby lead not only to increased attention to commercials but also to a favorable evaluation of what is being advertised.

Viewers' moods may be influenced far more by program content than by nonverbal or verbal commercial content. A certain "folk wisdom" regarding television advertising is that advertisers should avoid sponsoring overly depressing programs because the sadness will impact negatively on the advertised products. Mathur and Chattopadhyay (1991) studied effects of embedding advertising within programs previously judged through viewer ratings to be sad (a film based on the Nuremberg war crimes trials that followed World War II) and happy (a Walt Disney "classic" film). Commercials were for McDonalds™ food products and for life insurance from Mutual of New York (MONY™). The viewers who saw the happy Disney program seemed to process the advertising more thoroughly than the viewers who saw the sad Nuremberg program. The "happy" viewers showed greater recall.

In a previous study of happy vs. sad programs interacting with emotional vs. informational commercials for catsup, wine, coffee, and breakfast drink, Goldberg and Gorn (1987) found that happy programs elicited a happier mood in viewers. They also elicited greater perceived commercial effectiveness than sad programs, a more positive cognitive response, and better recall. The program-commercial interaction was such that the program effect was greater for those viewing emotional commercials, all of which contained music, than for those viewing the informational commercials. In general, emotional versions of commercials tended to outperform informational commercials regarding felt mood, perceived commercial effectiveness, and intention to purchase. Informational commercials elicited greater recall, but, of course, there was more to recall than in the emotional versions.

Whether or not music indeed does what it should do in arousing favorable associations or building positive moods in the context of a commercial that exists within a program is not easy to evaluate. Judgment of an advertisement's efficacy on viewers' abilities to recall presented information is too limited without giving attention to the nonverbal aspects, including music, which allegedly are building a positive feeling (Haley, Richardson, & Baldwin, 1984). There are numerous investigations of music's effects.

Wintle's (1978/1979) study of the dimensions underlying response to television commercials supports the contention that music makes a difference in a commercial. In a series of three studies in which college students respond-

ed to commercials with and without music, three factors emerged: activity, pleasantness, and potency. In the third study, which paired commercials respectively with a supporting music excerpt, results showed that supporting background music "routinely intensified the dimension positively characterized by a commercial" (Wintle, 1978/1979, p. 5115A).

Conceivably, music's effects in advertising may result from classical conditioning, where something linked to a favorable response from a prior association (e.g., "Nice music"–"I like it") becomes a signal for a similar response (e.g., "the advertised product"–"Nice music"–"I like it").[8] Gorn's (1982) pen study, discussed above, presumably exploited the idea of generalizing a favorable response to music to a particular product, i.e., the blue or the beige pen.

North and Hargreaves (1997, pp. 269–273) agree that the classical conditioning paradigm may be a likely explanation for music's effectiveness in some advertising but question its potential for explaining music's effectiveness in all commercials. They note that classical conditioning seems to explain effectiveness when the listener/viewer has *low involvement* with the product, i.e., has little motivation, ability, or opportunity to consider the quality or utility of the product. In such cases it is simply a matter of the commercial persuading the listener/viewer to *prefer* an advertised product over its competitors. In other instances, where the listener/viewer has *high involvement* with the product, i.e., has the motivation, ability, or opportunity to consider the product's quality or utility, the classical conditioning paradigm seems insufficient. North and Hargreaves suggest that a listener/viewer engaged in processing information about a product's quality or utility is employing the *elaboration likelihood model*, which they believe better explains how music influences the listener/viewer when such interest is involved. They maintain, however, that music for commercials allowing high level listener/viewer involvement must "fit" the commercial's nature and the listener/viewer's subjective perceptions of the music's appropriateness to the commercial's central message. To "fit" a commercial, the music might increase attention to it (be played louder), reduce the cognitive load (use slower rather than faster music), or call attention to cues for relevant knowledge about the product. North and Hargreaves consider the classical conditioning paradigm a *peripheral* route to persuasion and the elaboration likelihood model a *central* approach to persuasion. They summarize music's effectiveness in commercials as follows: "In short, music may be effective in commercials because it communicates meaning/information as well as affect" (p. 273). A number of

[8]Chapter 10 describes classical or Pavlovian conditioning. Conditioning occurs in many aspects of human behavior. In the advertising context, the advertised product presumably becomes a signal for a previously conditioned stimulus of favorable music, which in turn elicits some positive response.

the studies reviewed below deal either directly or indirectly with the appropriateness of the music's "fit" with the commercial; also, more information is provided regarding *peripheral* and *central* processing of commercials.

While educational television programs are not strictly commercials, successful programs must hold the attention of the intended audience, often children, just as a successful commercial must attract and hold attention. Music may attract attention, but it also may be distracting. Wakshlag, Reitz, and Zillman (1982) conducted two experiments regarding music's effects on 50 first and second graders watching educational television. In one experiment, the children watched, singly, 10-minute presentations on mathematics, use of the dictionary, earth/sun relationships, and gravity. The earth/sun film had background music; the gravity film did not. The mathematics and dictionary films, which represented the experimental variable of content, were shown in fast background music (MM = 100–170), slow background music (MM = 36–60), and no background music conditions. No adult was present in the viewing room; channel selection monitoring equipment recorded what each child watched. For both content areas, fast music resulted in significantly more viewing time than slow or no music; there were no effects for program part, gender, or grade.

In the second Wakshlag et al. experiment, children watched, in pairs, a program on a Lapp shepherd and a program on submarines; the investigators observed them via a hidden camera. Again, there were no significant gender or grade differences, and this time there were no differences regarding the music condition. However, there was a significant interaction with program time segment. The children's attention declined across the 7-minute programs, and the decline was greatest for fast music. No music showed less decline, and slow music showed little decline; slow music apparently was more effective in maintaining attention. A measure of what the children learned showed that learning was lower in the music conditions, and lowest for fast music. Background music did not influence the children's overall evaluation of the films. The investigators suggest that background music perhaps should be intermittent rather than continuous, as it was in their experiments.

Macklin (1988) considered whether music would distract children or attract their attention and result in a more positive attitude. In one experiment, pre-school children viewed mock cereal commercials in one of three conditions: no music, accompaniment by words and music of a professionally-composed jingle, and accompaniment by the jingle's instrumental music minus the words as a background. While lacking statistical significance, results showed that children who experienced instrumental music had more positive attitudes toward the commercial and the alleged brand of cereal. In a second experiment, preschool children had toys available and were organ-

ized into groups of three to view a Tom and Jerry cartoon containing embedded commercials. (Such a situation is more realistic; many American children "watch" cartoons with the television set functioning as an accompaniment to other play and give only occasional attention to the program.) There were no significant differences, except that the children exhibited increased visual attention in the no music condition. While Macklin does not mention it, the increased attention may be an artifact of a sudden change in "background" stimulus; Tom and Jerry cartoons, as many others, include almost continual music throughout.

The time and type of music may influence its popularity with particular audiences; these have implications for selecting music for commercials. Seminal research in music therapy (Gibbons, 1977) showed that elderly people tend to prefer music that was popular in their youth, and Holbrook and Schindler (1989) found that preferences for popular music are a function of when the music was popular in relation to the listener's lifetime, with the greatest peak of popularity for songs popular around the listener's age of 24. They suggest that social relationships and development of sensitivity may be responsible and that the age-related phenomenon may exist for other areas.

Rock music of previous decades increasingly is incorporated into commercials to provide an aura of familiarity and identity for the audience and potential customers of the "baby boom" and following generations. Presumably, listeners will identify with the song and then with the advertised product. Shea (1988, p. 49) noted an increase in the market share of Ford Motor Company's Lincoln-Mercury division allegedly due to music and the similar use of rock music commercials by the rival General Motors Corporation (p. 57).

Sullivan (1990) embedded advertisements for a chicken sandwich at a fast-food restaurant and a new entree at a seafood restaurant within programs consisting of adult contemporary (AC) and easy listening music.[9] (There was no disk jockey talk–just commercials and music.) Listeners of various ages heard the tapes. The AC listeners consistently showed more recall of advertising claims, a better attitude toward the commercials, and a stronger intent to try the food than did the easy listening audience. Sullivan predicted this on the basis of the AC music format being more "involving."

Stout and Leckenby (1988) had 1498 people, 90 percent of whom were female, respond to 50 commercials, representing nine product categories:

[9]AC radio generally features relatively unabrasive "soft" rock music styles, with disk jockey presentations that are oriented toward adults, especially in the 25- to 54-year-old range. Variation exists; AC stations may stress older songs, "full-service" radio, "romantic" songs, or alternative forms of unabrasive popular music. Easy listening implies less or possibly no rock, with an emphasis on instrumental music, nostalgia, and targeting to audiences aged 45 and older. Radio format labels may be confusing and inconsistent and are subject to evolutionary change; Barnes' (1988) classification remains useful.

flavored coffee, instant coffee, soft drinks, candy, pudding, muffins, beauty aids, laundry detergent, and a fast-food restaurant. There were 11 different brands, with two to 11 commercials per brand. Forty commercials included music. The respondents answered open-ended questions and responded to 52 evaluative statements. Of the 52 statement variables, only five showed any significant differences: Respondents were more positive regarding feeling as if they learned something, feeling not "talked down to," feeling untired of the commercial, and not feeling as if they heard the same thing repetitiously for the commercials with no music. But they said that they were more likely to *buy* products that had been presented *with* music. There were no significant differences in brand recall. The commercials with music in a major or mixed mode generally were evaluated more favorably than music in a minor mode. Commercials featuring music at faster tempi generally were preferred to those featuring slower tempi.

Alpert and Alpert (1990) considered particular musical characteristics as they investigated music's effects on mood and intention to purchase. On the basis of prior ratings, the investigators selected three friendship greeting cards–a happy, a sad, and a neutral card. Using the stereotypical major-happy/minor-sad dichotomy, the investigators contrasted the major and minor preludes from Book I of J. S. Bach's *Well-Tempered Clavier.* Subjects other than the experimental subjects rated the preludes for familiarity and preferences, and the investigators selected "Prelude III in C# Major" and "Prelude XXII in Bb Minor" as two relatively obscure but strongly preferred contrasting pieces. Forty-eight marketing students, organized into three listening groups, saw brightness-controlled slides of the three card types, with the music condition–happy, sad, or no music–varying systematically. While viewing and listening, the students drew a continuous line across columns characterized by a five-point Likert scale (the investigators call this technique the "mood monitor") to show changes in their moods across time. They also described each card with 10 semantic differential scales, including a "happy-sad" scale to assess perceived mood and a "would buy it-would not buy it" scale to assess purchase intention. A multiple analysis of variance showed no effects due to subject grouping, but there were significant effects on perceived mood due to card and music. In order of perceived happiness, with the happiest combination first, the card-music combinations were (1) happy music/happy card, (2) no music/happy card, (3) happy music/neutral card, (4) happy music/sad card, (5) sad music/happy card, (6) sad music/neutral card, (7) no music/neutral card, (8) no music/sad card, and (9) sad music/sad card. Further analysis showed that when the music condition was controlled statistically, the cards differed significantly, but when the cards were controlled, the music did not differ significantly. When purchase intention was the dependent variable of interest, the card-music combinations in order of

most to least likely to purchase were (1) sad music/neutral card, (2) sad music/happy card, (3) no music/happy card, (4) sad music/sad card, (5) no music/sad card, (6) happy music/happy card, (7 and 8, a tie) no music/neutral card, happy music/neutral card, and (9) happy music/sad card. Sad music was more effective regarding purchase intent, perhaps because of the reasons why the subjects might purchase a card. Obviously, variation in musical structure is important in determining effects; the investigators caution that generalizing from a laboratory-based study such as theirs to a "real" business situation is difficult.

Logically, one should ascertain that the type of music fits the commercial's overall theme. Garfield (1988) discussed the necessity for unity between image and sound and the importance of not overusing music.

Hung's (2000) study of the effects of congruent (matched) and incongruent (mismatched) music in TV advertisements on 134 MBA students' responses to eight conditions of music and videos underlines the importance of fit in commercials. Two musical scores, two videos, and four coffee commercials were presented in matched and mismatched formats. Music that evoked different meanings than the other information of the ads affected subjects' perceptions of the commercial and the advertised brands. Music in congruent ads reduced "noise" by reinforcing the connecting cultural context to communicate meaning.

Olsen (1996) examined the effects of intermittent background music where silence immediately preceded the presentation of crucial information on 144 undergraduates' response to radio commercials. Ads containing silence just prior to crucial information increased subjects' retention of ad information more so than either ads containing background music throughout or no background music throughout. No differences in retention occurred between the continuous music and no music conditions.

A particular complication in fitting music with advertising relates to viewers' inherent interest in and value for what is advertised. Petty, Cacioppo, and Schumann (1983) noted that the way a potential consumer processes information from an advertisement may vary: If there is high cognitive involvement, as there might be in the case of an expensive item, *central processing* is involved; with low cognitive involvement, as is likely in determining which soft drink to purchase, *peripheral processing*, with less concern for any particular issue and less motivation for a decision, is involved.[10] Golden and Johnson (1983) also address cognitive involvement when they distin-

[10]In this context, *central* and *peripheral* processing refer to the intensity of cognitive involvement. This differs somewhat from the terms' above use by North and Hargreaves to refer to the directness of the message, and differs substantially from the use of the terms in the psychoacoustic sense, discussed in Chapter 4, where a central process occurs primarily in the neural pathway or brain while a peripheral process occurs primarily in a sense organ.

guish between *thinking* commercials, which make relatively objective appeals to a presumably rational individual, and *feeling* commercials, which appeal more to emotions, perhaps through drama or music. Park and Young (1986) found more effects of cognitive involvement than of background music in a study where groups of adult women watched shampoo commercials that differed in presence or absence of music, with different sets of instructions designed to arouse different degrees of involvement with shampoo and beautiful hair.

The use of music to enhance advertising probably will be subject to continuing research, as will most applications of functional music. Whether the music attracts attention, reinforces a message, induces a mood, or simply entertains, the possibilities for music making a product or service more appealing arise from music's deep involvement in human culture.

Music as Entertainment

Music's entertainment function today is intertwined inextricably with the popular music industry. To "entertain" is to amuse or divert. Many forms of entertainment exist, and the popular music industry, often called the "music business," is one major form.

The history and function of the contemporary music business is a fascinating potpourri of music, recording technology, multimedia presentations, marketing, copyright law, and educated guesses regarding what will be popular when. A detailed discussion of the music business is beyond the scope of this text; the reader is referred to the illuminating descriptive works of Brabec and Brabec (1994), Denisoff (1986), and Fink (1996), as well as Krasilovsky and Shemel's (2000) encyclopedic examination of the music business.

Persons working in popular music may be considered "artists," but most appear to develop their art for commercial gain rather than artistic values. A musical style and image must "sell"; this takes priority over artistic values.[11] As Mussulman (1974, pp. 141–142) notes, artists and composers of popular music are engaged in a commercial enterprise, resulting in music that can survive *intensive* exposure for a relatively short time period, while art music ("classical" music) requires and survives *extensive* exposure. The use of marketing skills, image, and packaging is essential for popular musical success. Musical talent is not enough, and, as Frith (1988) describes, in some models of musical success, the actual performance is only one part of a much larger

[11]Of course, many performers would deny this. Performers may need to tailor their performance to public taste in order to win an audience; once they have some stature, they may be more free to experiment with their own musical beliefs and preferences. Ironically, if a performer becomes *too* popular, other performers or cult-like listeners may accuse him or her of "selling out."

enterprise.

Commercial interests are the overriding influence in the selection and promotion of popular music, whether the goal is to attract people to attend live performances, listen to music on the radio, view music videos, buy CDs and other recordings, or subscribe to specific listening formats now available in homes and automobiles via satellite and other telecommunication systems. Rothenbuhler and McCourt (1992, pp. 104–106) strongly assert, and North and Hargreaves (1997, p. 279) reiterate, that the primary concern in selecting music for radio airplay is to attract listeners to the advertisement breaks. Schwichtenberg (1992, pp. 117–122) makes a strong case that the primary function of music videos is to increase sales of the musicians' recordings and increase attendance at their concerts. North and Hargreaves (1997, p. 279) argue that another goal of music videos is similar to that of commercial radio: to attract specific audiences and keep those viewers watching until the next advertising break.

Hodges and Haack (1996, pp. 519–520) note that influences other than commercial are a part of at least one segment of the popular music industry: heavy metal music. Referring to these influences as a type of *musical malpractice*, they cite Stuessey's (1990) concerns about the content and themes of heavy metal: extreme rebellion, extreme violence, substance abuse, sexual promiscuity and perversion, and Satanism. Many parents, clergy, teachers, and community leaders are very concerned about possible negative effects of these themes in heavy metal, rap, and other popular music on teens' and preteens' behaviors and values. They also maintain that the visual images of such music's associated video productions greatly magnify the music's powerful and often violent messages.

Establishing *causality* between teens' and preteens' listening to certain types of popular music and the extent of their socially undesirable behaviors obviously is quite difficult, particularly given the many other variables that may influence such behaviors, e.g., personality, peers, and a multitude of other social and environmental conditions. Hodges and Haack (1996), citing several reports on adolescents and popular music, suggest that, even if causality cannot be demonstrated clearly, interactions undoubtedly exist. The alleged influence of some types of popular music on young people's socially undesirable behaviors will continue to be debated.

Country music also has been accused of having socially undesirable influences. Stack and Gundlach (1992) report a direct relationship between the suicide rate of urban whites and the frequency with which country music is played on urban radio stations. Again, causality has not been established, but the often sad and depressing content of much country music could be a factor.

Whether listening to heavy metal, rap, country, or any other specific type

of music may cause or be a catalyst for socially undesirable behaviors will remain difficult to establish. Even if investigators could establish causality, the sheer power of popular music, its pervasiveness through a wide variety of media, and its role as a socializing agent among young people undoubtedly will override the concerns of parents, teachers, and other interested citizens.

The popular music industry remains a major commercial enterprise that serves an important entertainment function for people of all ages, especially teens and preteens. Popular music fulfills important social roles, and may go beyond entertainment as a social force. Frith (1987, pp. 140–144) notes that although the popular music industry has capitalized on adolescents' social needs and music's power for commercial gain, it also serves important social functions for adolescent subculture. Gracyk (2001) suggests that rock music is a form of "mass art," something beyond popular culture. It has no single meaning; people with diverse interests and cultural backgrounds may identify with the music. Bertrand (2000) recounts how Elvis Presley, one of the most popular individuals of all time, embodied and manifested great changes in American culture as African-American traditions affected the then dominant white culture of the 1950s: Presley could make music characteristic of African-American styles in a white body. Perry (1988, p. 77) asserts that while racial barriers always existed in popular music, the barriers were more surmountable than barriers in any other cultural area. Bindas (1992) describes how swing bands broke racial and ethnic barriers during the 1930s. All the social gains were real, but they largely were stimulated by a desire for commercial gain. Yes, popular music is entertaining, and serves and has served important social functions. But financial gain is what drives the popular music industry.

Music for Enhancing Narration

Mussulman (1974, p. 103) argues that one of music's most important uses in Western culture is to enhance the emotional qualities, words, actions, or images in film and television dramas. One might insist that this use of music is more "artistic" than commercial, but the production of television and film music clearly has become a huge commercial enterprise. Composing, performing, and scoring such music is a multimillion-dollar business.

Music is an organized sequence of sounds and silences. Any music event is sequential, just as is a linguistic event or a movement. A narrative is a representation, a sequence of events, a story. Since music is organized into sequential events, music may "tell" about events–i.e., narrate–in a designated order. A "narrator" such as a film or television producer may adjust music to flow along with the sequential order of events that comprises the story.

Music thus may narrate in and of itself, as in program music, and it may enhance the narration expressed in another medium.

Narration through music is possible in part because music is able to function as language, albeit a language less specific than any verbal language. Portnoy (1963, pp. 99–100) suggests that music is a language that can express different ideas simultaneously. Farnsworth (1969, pp. 94–95) believes that music is a language in the sense that it has a grammar and syntax that musicians use to communicate, but he feels that music does not convey detailed messages. Brown (1981) indicates that language, unlike music, is not specific to one sense modality. He finds more similarity between music and sign language than between music and spoken language, because signs represent or suggest their meanings while words usually are connected with meanings more arbitrarily. Furthermore, signs can not exist without some configuration, location, orientation, and movement, just as tones cannot exist without some pitch, loudness, timbre, and duration. As the authors discuss in later chapters, cognitive psychologists and music theorists try to show an organizational similarity between music and language due to the existence of an underlying "deep" structure.

Narration through music also is facilitated by cultural stereotypes that attach particular meanings to musical effects, which are perpetuated through use. Such stereotyped expectancies do not require musical training for development and may be the essence of music as narrative.

Tonal elements (pitch, loudness, timbre) lend themselves to stereotypical narrative portrayals. For example, certain narrative symbolizations or representations may be appropriate for a certain pitch range, in accordance with experience and tradition. Depiction of the pixie-ish character in Richard Strauss's tone poem *Till Eulenspiegels lustighe Streiche* uses a high pitch level. Sounds suggesting some ponderous giant or impending doom will be low; sounds suggesting something spritely or delicate will be high. Changes in loudness easily suggest something approaching or leaving. A particular timbre or tone color may signify a particular character or set a particular mood. Bassoon tone signifies the broomstick in Dukas' *Sorcerer's Apprentice;* in Prokofiev's *Peter and the Wolf,* the clarinet represents the cat. Low frequency timbres, such as those of the bass clarinet, may suggest a certain sense of mystery and foreboding; electronic sounds may suggest "eerie" effects. Stereotypes arise from perceived or imagined characteristics of that which is portrayed in relation to sonic qualities–one hardly would depict birds in flight with a tuba or a lion stalking its prey with a flute.

Sequential musical aspects (melody, rhythm, form) affect music's character and have considerable roles in musical narration. A familiar melody may arouse particular memories and anticipations, as exemplified by the use of nationalistic music, such as "La Marseillaise" accompanying ending scenes

and a dramatic confrontation in the classic American film *Casablanca.* Themes (incomplete melodies) may accompany particular characters, as exemplified by Wagner's use of the *leitmotif* in his operas and the use of themes to accompany characters in television situation comedies. A melody's mode may be important; the somewhat hackneyed stereotype of major = happy and minor = sad is one of the most heavily used stereotypes.[12] Ascending and descending melodic lines have obvious narrative utility.

Harmonic intricacy may suggest complexity or simplicity. Consonant harmonies may suggest rest or resolution of conflict, while dissonant harmonies may suggest activity, restlessness, or chaos. A polyphonic texture, which involves two relatively independent melodic lines, may suggest a continuing discourse or conflict.

Rhythm, which must exist in all music, is an obvious narrative tool. Tempo is a critical variable; it is the main distinction between stimulative and sedative music, which respectively may portray stimulative fast-paced activities and slow relaxing activities. Strong accents, especially when they occur at normally unaccented places as in syncopation, can create tension and excitement. Repetitive rhythms can build in psychological intensity. An incessant rhythm combined with a continuous increase in loudness, as in Ravel's *Bolero,* can produce particularly strong feelings of drive, determination, or inevitability.

All music has form, although the form may not be obvious. Unity and variety are the bases of form; repetition of earlier musical material may suggest a sense of completion. In narration, form's role probably differs between narration through music as the principal medium, where longer forms are required, and narration through another medium enhanced by music, where shorter segments are needed. Curiously, Portnoy (1963, p. 130) indicates that novelists may use musical forms to enhance their work and cites Huxley (1928, pp. 293–294) as an example of complicating plots in analogy with the many voices of a fugue.

One may question whether anything of a narrative nature is inherent in music, especially when there are no understandable words. Do the sounds automatically suggest certain sequences of events, or is learning involved? The authors believe that stereotypes and listeners' basic agreements regarding what they are hearing are from learned associations. Music to depict a large animal? Low pitched sounds. Music to depict a battle? Rapid tempi; full orchestration with rapidly changing higher pitched sounds and rhythmic lower sounds. Certain common utilities of experience and ideas exist regarding objects or events; within a particular culture, these translate into accept-

[12]Other musical characteristics, especially tempo, may override modality. A fast minor work may be "happier" than a slow major work.

able and appropriate music. Except as a joke, no one indoctrinated into the cultures portrayed by most American films and television would claim that a fast, loud, atonal electronic composition depicts a flower garden on a balmy spring day. A musical narrative in which someone triumphs over adversity can not avoid loud sounds. The melody and harmony appropriate for a love scene probably would not suggest unseen but sensed extraterrestrial beings. A trio of flutes hardly can signal a shark approaching a lifeboat. Basically, the reason that music may narrate, by itself or in the context of another narrative medium, is that people can associate acoustical events with real or imagined events in other sensory modes.

Television and films are theaters of illusion. Viewers are not actually in the loving couple's living room, on board the ship on the raging sea, or in the police car as it chases the criminals. They are watching and listening to a two-dimensional representation,[13] often in a rather confined area. The media intend to stimulate the view to perceive or imagine a sense of reality, often with the aid of music. Mussulman (1974, pp. 103–106) summarizes music's uses in theaters of illusion as (a) filling silence, (b) imitating or suggesting natural phenomena, (c) masking unwanted sounds, and (d) encouraging empathy for the figures on the screen. In describing one use of music to build suspense by arousing the imagination, Mussulman (1974, p. 106) reflects:

> We are looking over the shoulder of a cowboy who is scanning the distant horizon. Suddenly a lone horseman appears there, silhouetted against the rising moon. Is he friend or foe? The cowboy cannot tell us for sure, but a sudden loud (*sforzando*) dissonance warns us that danger is imminent.

Cohen (1999) details eight functions of music in multimedia presentations; she documents all in supporting research. One is *masking,* which includes covering extraneous sounds as well as nonmusical sounds incidental to the narrative, such as crowd noises. Another is *continuity,* where music's sequential aspects enhance the flow of narration, especially across changing scenes. *Directing attention* is a third function; music may direct attention to specific aspects of a visual scene, as when music signalling arrival of a train or plane increases in loudness as the conveyance approaches. *Mood induction* is similar to the use of background music in stores; the music is a tool for eliciting a particular mood or feeling among viewers. Music may *communicate feeling* and resolve communicative ambiguities; Cohen (p. 58) cites an earlier study (Cohen, 1993) in which background music influenced whether viewers interpreted vigorous group interaction as fighting or playing. Music may be

[13]Of course, "3D" movies, which exploit stereo-optical effects to give an impression of depth, have been available since the 1950s, and "virtual reality" technology seems to place the observer in the action. Even with the impression of depth, the narrator still relies on illusion.

a *cue for memory,* as in the classic use of the *leitmotif* for eliciting recall of a scene or an event. Music may make events more realistic by *heightening arousal and suspending disbelief.* Finally, the music may serve an *aesthetic* function as music, beyond any narrative facilitation.

Music unquestionably is a vital part of the film and television industries. Film music and the film itself may have a symbiotic marketing relationship, partly as an extension of Cohen's cue for memory and aesthetic functions. Over two score years ago, Haack (1980) described an "emerging" promotional alliance in which the film and recording industries (which now may have the same corporate owners) work together to popularize a film and its soundtrack. Repetitive musical material in a film provides ample opportunity for implanting music in tonal memory, and on-the-air performance of a film score provides commercial messages for the film. And all because of our learned associations.

Therapeutic Uses of Music

Although people have espoused music's healing, soothing, and persuasive effects throughout history, music has come to be systematically used toward therapeutic ends only during the past half century or so. Michel (1985, p. 5) notes that music therapy came into widespread use in the United States only since about 1946. The National Association for Music Therapy (NAMT) was founded in 1950.[14] The development of music therapy as a profession, especially in North America, was coordinated and promoted primarily through NAMT; the American Association for Music Therapy (AAMT) also played a role, particularly in the eastern United States. During the 1990s, NAMT and AAMT completed an extensive merger process; the first national meeting of the resulting American Music Therapy Association (AMTA) occurred in 1998. To be fully credentialed as a music therapist, an individual must graduate from an AMTA approved program and pass a national certification examination, administered by the independent Certification Board for Music Therapists.

The founding principles that underlie therapeutic uses of music, as stated by Gaston (1968a, p. v), were that music in therapy should facilitate

1. *The establishment or reestablishment of interpersonal relationships,*
2. *The bringing about of self-esteem through self-actualization,*
3. *The utilization of the unique potential of rhythm to energize and bring order.*

While these principles remain valid, music therapy's potential in contemporary society has broadened considerably in scope. Music therapists today

[14]For a review of music therapy organizations in other countries, see Michel (1985, pp. 103–110).

are professionally trained individuals who use music as a medium to help influence desirable changes in their patients. As Davis and Gfeller (1992, p. 6) state,

> the music therapist's major goal is to change the behavior of a client so that unwanted, uncomfortable, and unhealthy conditions are replaced with more adaptive ones. Music is used as a medium to help people maintain or improve important life skills in the areas of communication, academic performance, gross and fine motor development, social skills, and emotional development.

Michel (1985, p. 11) notes that today's therapist is no longer restricted to working with patients with specific behavioral, emotional, physical, or mental disorders; rather, today's therapist is viewed as a generalist with special *musical* tools that may be adapted to meet the professionally assessed needs of various patients. The therapist's musical tools include two particular aspects: (a) the basic power of the musical stimulus to arouse or soothe activity and (b) music's traditional functional values as a socializing agent and as a symbol or vehicle for expressing patriotism, religion, or fraternity.

The uses of music in hospitals and outpatient treatment settings include a variety of specializations for patients with particular needs. As a therapy encouraging active rather than passive behavior, music therapy requires the patient to engage in "doing" music through singing, listening, discussing, creating, playing instruments, or moving. The music therapist usually is a member of a professional team, often headed by a psychiatrist or clinical director, which outlines the particular patient's therapeutic program. The team may select music therapy as the particular medium or as one of several therapeutic media for facilitating behavioral changes. A particular value of an active form of therapy is that it requires an interpersonal relationship between the therapist and the patient, as well as relationships within a group.

Prior to starting a music therapy program with any particular client, the music therapist should assess whether music therapy is potentially beneficial by observing and evaluating behaviors in six categories–communication, academic (or cognitive), motor, emotional, organizational, and social (CAMEOS). The CAMEOS categories in turn become appropriate areas for setting therapeutic goals (Eagle, 1982, p. 21; Lathom-Radocy, 2002, p. 3).

In determining the specific music activities for individual patients, the music therapist considers many factors, including the recommendations of the therapeutic team, the patient's disabilities and behavioral disorders, the objectives for the therapy, and the patient's musical background and interests. While the therapist may establish musical goals, these are secondary to the behavioral and social goals established by the therapeutic team. The music therapist must select activities that capitalize on music's stimulative

and socializing strengths to actively involve the patient while simultaneously facilitating the desired behavioral changes.

The approach described above sometimes is considered *music in therapy*, wherein the music itself is adjunct to and complements other interventions; approaches in which music is the main treatment for improving a client's condition are considered *music as therapy* (Bunt, 1997, p. 258). Obviously, the line between music *in* therapy and music *as* therapy is not demarcated as clearly as Bunt suggests, but recognition of the two approaches sometimes is useful. Unkefer's (1990) taxonomy of music therapy programs and techniques for adults with mental disorders, which classifies activities and interventions into six major categories, essentially reflects the music *as* therapy approach.

The first category is *music performing;* performing activities may focus on either product or process and may involve either group or individual interventions. Group activities emphasize group cooperation and responsibility, social interaction, and mastery of musical material. Techniques with individuals may focus on improving a client's musical skills (product) or fostering a client's self-expression and ability to interact musically and socially with the therapist or others in the group (process).

Unkefer's second category, *music psychotherapy*, includes supportive, interactive, and catalytic therapy processes for groups and/or individuals. Supportive music therapy activities foster verbal interaction, social participation, and the practice of healthy behavior patterns. Interactive activities seek to help clients become aware of conscious conflicts and unhealthy defense mechanisms and to gain insights into behavior patterns. Catalytic activities seek to create an awareness of subconscious conflicts and encourage change by reliving and resolving deep conflicts and fears.

In Unkefer's third category, therapy using *music and movement* may help clients become aware of their body mechanics, increase social interaction, allow expression of feelings and emotions, and increase exercise. In category four, *music combined with other expressive arts* such as drawing, drama, sculpting, or writing prose and poetry offer individuals increased opportunities for therapeutic expression of feelings and emotions. *Recreational music,* category five, features a focus on cooperative group participation, success-oriented musical experiences, and the development of leisure-time musical skills.

In *music and relaxation,* Unkefer's sixth category, four recognized techniques employ music to foster relaxation: (a) music used in conjunction with progressive muscle relaxation training; (b) music for surface relaxation and temporary respite from anxiety/stress conditions; (c) music imagery to explore and foster increased self-awareness, which may lead to psychological and physical relaxation; and (d) music as a positive perceptual focus and diversion from anxieties, fear, tension, and unpleasant thoughts.

Documenting music therapy's effects via carefully controlled research is understandably difficult. The clinical approach necessary in many music therapy activities lends itself more to case study research than to experimental research. Further, since music therapy is used in conjunction with other therapies and medications, it is difficult to attribute any effects solely to music; also, the individual therapist's personality is an important variable.

A review of the research literature on particular applications of music in therapy is well beyond the scope of the present discussion, but Standley's (1986) meta-analysis of empirical studies using music in actual medical/dental treatments warrants discussion. She identified 81 studies for possible inclusion in the meta-analysis, but only included 30 because the others had (a) failed to report empirical data; (b) used simulated diagnosis, treatment, or pain stimuli; (c) used auditory stimuli other than music; or (d) reported results in formats not amenable to replicated data analysis. Standley employed the *estimated effect size* (ES) statistic as an indication of the extent to which the music condition made a difference.[15] For 54 of the 55 variables analyzed,[16] Standley found (p. 79) "music conditions enhanced medical objectives whether measured by physiological (ES = .97), psychological/self-report (ES = .85), or behavioral observation (ES = 1.10)."

From the comprehensive data contained in the 30 studies subject to meta-analysis, Standley (pp. 81–97) identified seven types of music therapy applications and techniques for use in medical settings. Following is a list of the techniques and the function the music is intended to serve for each technique. Readers interested in the therapeutic objectives, populations for whom the techniques are intended, and the procedures involved in application of the techniques should consult Standley's article, a major contribution to the field.

1. *Technique:* Music Listening and Anesthesia, Analgesia, and/or Suggestion
Music Function: To serve as an audioanalgesic, anxiolytic, or sedative.

2. *Technique:* Music Listening/Participation and Exercise

[15]ES represents the proportion of a standard deviation (a unit of variability) that quantifies the experimental effects of contrasting conditions. In this case, the means of the groups receiving musical treatment were contrasted with the groups that did not. An ES = 1.00 would indicate that, across all the studies in the meta-analysis, the experimental group (musical treatment) scored one standard deviation better than the control group (no musical treatment). The ES statistic is becoming more common in single studies as well as in meta-analyses because it gives some indication of the "practical" significance of a result. Classical statistical significance may accrue for practically trivial results, especially with large samples.

[16]The number of variables analyzed was greater than 30 because some studies included more than one dependent variable.

Music Function: To serve as a focus of attention and/or to structure exercise (tempo, repetition, duration force, or fluidity).

3. *Technique:* Music Listening/Participation and Counseling
Music Function: To initiate and enhance therapist/patient/family relationship.

4. *Technique:* Music Listening/Participation and Developmental or Educational Objectives
Music Function: To reinforce or structure learning.

5. *Technique:* Music Listening and Stimulation
Music Function: To stimulate auditorily and increase awareness of other forms of stimuli.

6. *Technique:* Music and Biofeedback
Music Function: To serve as reinforcer or structure for physiological responses.

7. *Technique:* Music and Group Activities
Music Function: To structure pleasurable and positive personal interactions.

Hodges and Haack (1996, p. 544) note the development of two new fields related to music therapy: *music medicine* and *performing arts medicine. Music medicine* appears to involve using music more in terms of physical health than much traditional music therapy, which seems to focus as much or more on psychological health. A major difference between music medicine and music therapy is that a health care practitioner, such as a physician or nurse, normally administers music medicine, not a music therapist (Hodges & Haack, 1996, p. 544). Many of music medicine's goals appear similar to music therapy goals, e.g., using music to control pain; reduce blood pressure, heart rate, or muscle tension; and promote changes in the endocrine system. Obviously, there are philosophical and territorial issues: Administration of music for therapeutic ends without the involvement of a board-certified music therapist (MT-BC) may be like a music therapist administering medical treatment without the involvement of a physician. Undoubtedly, much professional (and perhaps some less-than-professional) discussion must occur for music medicine and music therapy to interact effectively in working toward the best interest of clients.

Performing arts medicine essentially is a specialty among physicians concerned with treating medical injuries and problems of musicians, dancers, and other performing artists. Typical injuries include "overuse syndrome,

carpal tunnel syndrome, nerve entrapment, and vocal nodules" (Hodges & Haack, p. 544). Performing arts medicine is somewhat akin to speech therapy and sports medicine in that the primary purpose is to treat and alleviate physical factors that prevent a performer from achieving his or her full potential.

As with most developing fields, many issues require consideration, especially since music therapy itself is still an expanding field. For example, how will the emerging fields interface with already established music therapy goals and approaches? Who has the expertise to use music for improving physical and psychological health care? What type of professional certification should be required for those using music for health care purposes? What types of working relationships need to be established between music therapists and other health care professionals? How does one educate the public that simply using music as a diversion or entertainment is not music therapy?

While music therapy still is a relatively new application of music within the health care community, it appears to have a much stronger research base than other functional applications of music, including music medicine and performing arts medicine. Standley and Prickett's (1994) compilation of key articles appearing over a 30-year period in the *Journal of Music Therapy* offers a comprehensive description of much of that base. Health care professionals recognize its value as a therapy embodying active involvement, and research, training, and other standards for the profession are high, thus strengthening the profession's position within the medical and paramedical community. In conclusion, there is little doubt that the ideals and principles under which music is used in therapy make music therapy one of the most, if not *the* most, valuable functional applications of music.

Music to Facilitate Nonmusical Learning

Many claims have been made regarding music's effects on nonmusical learning. Students of all ages often claim that they study more effectively while listening to music. When faced with program cutbacks in schools, many American music educators have sought to justify music's curricular position by suggesting that music facilitates learning in other curricular areas. For example, a periodical of the Music Educators National Conference headlined an unsigned article in the February 1995 *Teaching Music*[17] with "Music Makes You Smarter!" Drawing on some of the early "Mozart effect" research, the article generalized far beyond the data and claims made by the

[17] *Teaching Music* is a nonscholarly adaptation of the older quasi-refereed *Music Educators Journal*. It functions mostly as a newsletter to express current interests of the headquarters staff of the Music Educators National Conference and rarely employs the expertise of the research community.

researchers. (Considerably more is said below about the "Mozart effect.")

While the "Mozart effect" has received the most attention during the past decade, the notion that music facilitates nonmusical learning is not new. Perhaps its timing, in conjunction with the political agenda of the MENC, however, has brought the matter of music's effects on nonmusical learning to the fore. This section examines some of the literature and views regarding the matter.

Music has been used in a number of different ways in attempts to facilitate nonmusical learning. One approach is to use music or musical activities as a reward for accomplishing a given task. Research on using music as a reward for behavior change or accomplishment of a given nonmusical task is somewhat limited. Vance Cotter (1973) was a pioneer, but Clifford Madsen and his students and alumni published much of the relevant research (Madsen, Greer, & Madsen, 1975; Madsen & Prickett, 1987). While much of the reported research uses behavioral techniques to facilitate musical learning, much uses music as reinforcement or as a reward for nonmusical behavioral change. In either case, learning generally is viewed as an observable change in behavior, and most of the research reflects careful control and isolation of variables.

Cotter (1973) studied the effects of contingent and noncontingent music on the performance of manual tasks in a simulated workshop situation by 16 moderately retarded adolescent females. Subjects in the noncontingent group, i.e., the one receiving music regardless of their work performance, did not achieve a higher mean work rate, while subjects in the contingent group, for whom receiving music depended on work rate, did increase their mean work rate.

Madsen and Forsythe (1975) examined the contingency effects of individual music listening (via headphones), group music listening, mathematics games, and no reward on sixth graders' mathematical achievement. Results revealed statistically significant differences in favor of the two groups receiving music. A subsequent study, in which the contingency for first graders' mathematical achievement was viewing televised music lessons, also revealed greater achievement for the group viewing the music lessons than for a control group receiving no reward (Madsen, Dorow, Moore, & Womble, 1976).

Madsen and Geringer's (1976) study of the effects of choices of reinforcement indicated that televised music lessons were just as effective as free play in increasing children's academic skills. Madsen's (1981) later study comparing the effects of televised music lessons and receiving books as reinforcement alternatives for mathematical achievement also revealed that both were effective in promoting increased mathematical performance. The televised music lessons, however, had the advantage of facilitating musical achieve-

ment.

The above studies suggest that music can function as a reward for achieving nonmusical tasks, but the extent to which these results can be generalized and applied to other learning situations is subject to conjecture. Madsen and Forsythe (1975, p. 31) acknowledge that studies of this type have several problems, including "Hawthorne" and "halo" effects as well as all of the effects presumed to operate in school settings.[18] However, the studies do indicate that music as a reward is equally effective as other contrived classroom contingencies and perhaps has the additional effect of facilitating learning in music.

Research on music as a reward for nonmusical learning has waned in recent years. Whether this is because the researchers view it as a given that no longer requires research or whether research and philosophical perspectives have simply changed is unclear. Whatever, approaches using music to facilitate nonmusical learning have taken other directions.

Wolff (1978) and Hanshumaker (1980, 1986) have provided comprehensive reviews of much of this research. Hanshumaker's reviews also included studies regarding the effects of other arts besides music; one must bear this in mind when considering his generalizations.

Of the other approaches involving music to facilitate nonmusical learning, perhaps the most basic is that of examining the effects of musical experience and learning on achievement in other areas. Wolff labels this approach as *general learning transfer* in which "the study of music serves as mental discipline which expedites the learning of other subjects" (Wolff, 1978, p. 3). She also notes that the notion of training faculties of the mind already had been discredited by the time of Thorndike (early in the twentieth century). Other studies have investigated *specific learning* of certain tasks common to music and other subjects. An example of such a study is that by Madsen, Madsen, and Michel (1975), in which tonal cues were used to facilitate verbal auditory discrimination. Transfer of musical experience, both to others areas of music and to nonmusical tasks, is a complex topic, in which one must consider the type, dimensions, and direction of transfer. Tunks (1992) provides a detailed review of transfer theories and considerations.

Another approach using music to facilitate nonmusical learning is through the use of background music. While few specific claims are made regarding the effects of this type of music on academic achievement, there is interest in "how the environment can affect the learning process" (Muzak, brochure, no date). Interestingly, in a study of background music's effects on university

[18]The "Hawthorne" effect refers to an increase in performance that apparently occurs because a group perceives itself as receiving special treatment; the "halo" effect refers to a bias in evaluations arising from an evaluator's tendency to allow some general impression he/she has of the person(s) being rated to influence ratings of specific traits.

students' reading comprehension, Kelly (1993) observed no statistically significant effects.

Two other studies, however, suggest that music can be effective in facilitating academic achievement. Battle and Ramsey (1990) found that presentation of social studies facts to inner city sixth-grade students via a rhythmic song (rap) was more effective than a traditional presentation of social studies facts. Tanner (1991) observed that an approach to reading that incorporated ITA (Initial Teaching Alphabet) techniques in both reading and music instruction helped second-, third-, and fourth-grade students improve their skills in letter-word identification, passage comprehension, and word attack.

Taking a different approach to the problem, Manthei and Smith (1993) assessed the effects of music participation on high school students' mathematical achievement via regression analysis. After studying data from a sample of 1,192 subjects drawn from a pool of 12,000 students participating in the 1980 High School and Beyond survey, the researchers reported no statistically significant direct effect of music participation on mathematical achievement. However, based on analysis of the number of music participants who also were participants in mathematics courses, they did report an *indirect* positive effect of music participation on mathematical achievement (p. 81). Parsimoniously, music did not promote greater mathematical achievement, but perhaps the students who tended to enroll in music classes were the ones more likely to achieve well in mathematics.

Perhaps the most claims regarding the effects of music on nonmusical learning have been with respect to language learning (e.g., Snyder, 1994; Wolverton, 1991), but even here the literature regarding such effects is diverse and inconclusive. Readers are encouraged to examine Wolff's excellent review and status report on the topic. She also reviews studies that examine the effects of music experience on self-concept, personality factors, and certain physical activities.

Hanshumaker's 1980 review examines studies related to language development and reading readiness, reading and mathematics, learning behavior and attitude, creativity, socialization, and intellectual development and achievement. (His 1986 review essentially is an update of the 1980 review.) Generally, Hanshumaker concludes that music has positive effects on language development, reading readiness, and student verbalization. He also notes that daily music instruction has a significant, positive effect on mathematics scores and that creativity and perceptual motor skills are affected positively. A conservative but particularly important conclusion for music educators is that "school time spent on music and other arts activities has no negative effect on academic achievement" (Hanshumaker, 1986, p. 11).

Overall, Wolff is more cautious in her conclusions, although she agrees that measurable effects of music instruction on development of cognitive

skills and understanding may exist. She acknowledges that most of the research she reviewed reported positive results, but she maintains that the conclusions drawn generally remain unconvincing, primarily due to "obvious inadequacies in the experimental designs and also to the incomplete and equivocal descriptions of the experiments themselves" (p. 21). She concludes that "definitive evidence of the nonmusical outcomes of music education is yet to be provided" (p. 21).

A more recent review of the extra-musical advantages of music instruction and participation (Cutietta, Hamann, & Walker, 1995) also reflects considerable caution in its claims regarding music's effects on nonmusical learning. An outcome of the Future of Music Education Project sponsored by United Musical Instruments, U.S.A., a coalition of six major manufacturers of musical instruments–Armstrong, Artley, Benge, Conn, King, and Sheryl & Roth, the review reported results of 81 studies of the effects of music instruction or participation on achievement in language arts, reading, mathematics, other academics, and several other dependent measures (creativity, dropout rates, student self-esteem, student social skills, and student perceptual motor skill development). While the project reviewed 81 studies, only 34 actually concerned academic achievement, and over half of these only provided correlational data. Not surprisingly, Cutietta et al. were quite cautious in generalizations regarding the effects of music instruction on achievement. Of the 34 studies relevant to academic achievement, only six reported results that implied causal effects from music instruction or participation on academic achievement. Others either provided only correlational data or yielded statistically nonsignificant results. In essence, studies reviewed by Cutietta et al. did not provide convincing data showing positive effects of school music instruction or participation on academic achievement. Most conclusions were in terms of positive relationships between music participation and the various types of academic achievement, perhaps useful as political information but not convincing to researchers.

Perhaps the biggest ballyhoo regarding the effects of music on nonmusical learning has been that associated with the purported "Mozart effect." Because it illustrates taking minimal information and making it into something well beyond what it represents, the authors have elected to devote considerable discussion to the Mozart effect and the attention it aroused.[19] In a letter to the editor of *Nature,* Rauscher, Shaw, and Ky (1993) reported a comparison of three groups of college students, one of which listened to Mozart's D major sonata (K488), another of which listened to an unspecified relaxation tape, and the other of which sat in silence for 10 minutes prior to taking tests of spatial reasoning. The test scores were converted to the equivalence of intelligence scores, in accordance with instructions for the *Stanford-Binet Scale of Intelligence* (Thorndike, Hagen, & Sattler, 1986). The group that had listened to Mozart showed significantly higher scores than the others. The investigators carefully cautioned that their results were temporary and did not extend beyond the particular spatial reasoning tasks. They called for further research regarding additional styles and noted that musicians might react differently than nonmusicians. However, popular media, including publications of the Music Educators National Conference, ignored the researchers' cautions and promulgated a story that music could make a person "smarter." Hence, the beginning of the "Mozart effect" phenomenon, but the media blitz that followed went far beyond what Rauscher and her colleagues suggested.

[19]And this occurred despite the authors' warning in Chapter 11 of the third (1997) edition of this text!

Subsequent experiments suggest that the Mozart effect may be a real phenomenon in carefully limited situations. In one experiment (Rauscher, Shaw, & Ky, 1995), where college students were tested on their ability to imagine the results of a series of paper folding and cutting operations, the students who listened to 10 minutes of the Mozart sonata outscored students who either listened to other aural stimuli or sat in silence for the 10-minute preparation times over a period of five days. In another experiment (Rauscher, Shaw, Levin, Wright, Dennis, & Newcomb, 1997), three- and four-year-old children who underwent eight months of piano and voice experiments in preschool were superior in assembling puzzle pieces to children who had not had the musical experience. The researchers believe that they had shown how music might enhance cognitive spatial-temporal development. Evidently, similar cortical areas are involved in the types of musical processing and spatial processing required in their experiments.[20] Again, the investigators called for more research. A study of electroencephalographic recordings of cortical regions from seven adults (Sarnthein, vonStein, Rappelsberger, Petsche, Rauscher, & Shaw, 1997) revealed a carryover effect of cortical activity induced by listening to the Mozart K448 to performance on complex spatial-temporal tasks. Thus, research suggests an apparent causal effect between different kinds of tasks, with a strong neurophysiological basis, rather than simply a correlational one, and it *is* exciting. However, this hardly justifies claiming that music makes a person "smarter," which is what happened.

Despite the researchers' cautions, the media blitz continued, and politi-

[20]An elaborate description of a neural model from which the investigators drew underlying theoretical support appears in Leng, Shaw, and Wright (1990). The model partly involves periodic neural firing patterns in response to spatial-temporal tasks and musical stimuli, with particular firing patterns occurring for particular musical styles. Such firing patterns also are in accordance with Mountcastle's (1978) principle of cortical organization, under which the cortex is organized into tiny vertical columnar structures. In simple (and fanciful) terms, musical experience with appropriate structure may prime a cognitive pump.

cians got into the act. Articles in the *Miami Herald* and *USA Today* reported that Georgia's then-governor Zell Miller proposed that parents of all newborn infants in Georgia be given a CD or cassette of Beethoven's *Ode to Joy* to help stimulate their infants' minds. Articles noted that having the infant hear soothing music[21] helps the trillions of brain connections develop, especially the ones dealing with spatial-temporal reasoning, which were reported to translate into better mathematical, engineering, and chess skills. Other nonresearchers soon were to capitalize on the Rauscher et al. research.

Of the efforts to capitalize on "Mozart effect" research, perhaps the most blatant effort, certainly the one with the most *chutzpah,* was Don Campbell's (1997a) book *The Mozart Effect*™[22] and his accompanying (1997b) CDs, *The Mozart Effect: Music for Children.* The CDs include music from various Mozart works that purports to "strengthen the mind" and provide "music for intelligence and learning" (cover brochure).

Campbell (1997a, pp. 15–17) cites the work of Rauscher and her colleagues and credits them with bringing the Mozart effect to the public's attention. Campbell "interprets" the 1993 Rauscher et al. study as demonstrating that listening to Mozart "can improve your concentration, enhance your ability to make intuitive leaps, and, not incidentally, shave a few strokes off your golf game" (p. 16)! Campbell notes that the preschoolers' increased intelligence lasted at least one full day, which was one hundred times longer than the increase for college students. Regardless of the Rauscher et al. research, Campbell credits the "holistic" physician Alfred Tomatis with coining the term "Mozart effect." He states (p. 17) "it is undoubtedly the research of Alfred Tomatis, M.D., that has established the healing and creative powers of sound and music in general, and the Mozart Effect in particular." Where the truth lies is unclear.

Regardless of the impetus for the Mozart effect, an obvious question remains: Why Mozart and not music of other composers? Attributing most of the answers to Tomatis (*Pourquoi Mozart?,* 1991), Campbell (1997a, pp. 27–30) notes that Tomatis observed that Mozart's music "invariably calmed listeners, improved spatial perception, and allowed them to express themselves more clearly–communicating with both heart and mind" (p. 27). Campbell then suggests that

> the unique and unusual power of Mozart's music likely springs from his life, especially the circumstances surrounding his birth. Mozart was conceived in a rare space. His prenatal experience was daily suffused in music, especially the sounds of his father's violin playing, which almost certainly enhanced his neurological development and awakened the cosmic rhythms in utero. (pp. 28–29)

[21]Of course, *Ode to Joy* hardly is "soothing." Most people would find it stimulative.
[22]The superscript "TM," indicating "trademark," is no accident. The title page of Campbell's book says "*The Mozart Effect*™ is the registered trademark of Don Campbell, Inc., and is used with permission throughout this book." Note the capital E in "Effect."

Campbell suggests that Rauscher and her colleagues "intuitively grasped the connection between Mozart's early upbringing and the creative power of his music" (p. 28). Thus, more fuel for the Mozart effect!

Campbell's text certainly attracted attention. When it was new, one the authors wrote a review for a state music education publication (Radocy, 1997). To close the discussion of Campbell's metamorphosis of the putative cosmic rhythms Leopold Mozart awakened in fetal Wolfie, we quote a summary paragraph from that review:

> Campbell's metaphysical mixture of research and speculation undoubtedly will find an enthusiastic audience among true believers in spiritual healing, and it may interest some of the merely curious. As long as the reader recognizes that Campbell is not a member of the music therapy profession, a highly disciplined profession that requires careful preparation and adherence to standards of professional practice, and that while music may be a catalytic agent in a comprehensive healing process, it is not a cure, the text probably is relatively harmless and may be entertaining. In fairness, one also must remember the power of the human mind–if a person has a deep belief and faith in a particular power, whether the power of music, a healing method, medical technology, or a deity, that person may experience substantial benefits. However, the music educator who desires a serious examination of Mozart's music as a catalyst for learning probably will be disappointed. (p. 39)

For whatever reason, Mozart's music was deemed to have a positive effect on intelligence, and regardless of ludicrous claims that listening to Mozart makes one smarter and resulting expedient entrepreneurship, the question remains: Can the Mozart effect be demonstrated by others in the research community? Many researchers have sought to replicate its effects; in addition, much discussion has occurred among music psychologists, music educators, and other educators, as well as in popular media.

For example, Overy's (1998) provocative article "Can Music Really 'Improve' the Mind?" in *Psychology of Music* elicited six thought-provoking responses (Gruhn, 1998; Lamont, 1998; Mills, 1998; Rauscher, 1998; Spychiger, 1998; Waters, 1998). Most respondents concur that musical experience can improve the "mind,"[23] although they take quite different perspec-

[23]The authors hold that the mind is a process, what the brain does. The brain is an anatomical structure. (Please see the "who's right" section in Chapter 10's learning theory discussion.) Interestingly, music purportedly is improving the "mind," yet, as noted above, part of the theoretical rationale for demonstrable aspects of the Mozart effect, i.e., facilitation of spatial-temporal reasoning, involves cortical organization.

tives. Rauscher's response primarily discusses possible neurophysiological changes in the brain as a result of music experience, but she also delves into the political aspects of music education. Spychiger offers a qualified "yes," noting that music should not be viewed as something outside other aspects of the mind; she concludes with a discussion of the importance of good teaching. Lamont's review of studies leads her to conclude that we do not have sufficient evidence to conclude that music improves the mind. Mills generally agrees that music experience *can* improve the mind, but she questions whether it *does;* she concludes by noting that music's main purpose in schools should be musical excellence. Waters, an experimental psychologist, raises several methodological questions, including: What are differences in acute (one dose) and chronic (multiple dose) effects? What are differences in effects of music perception and music production? How are music's effects on cognitive performance related to music's effects on mood and arousal? He maintains that "theoretical models of music's enhancement effects need to be clearly articulated" (p. 208). Gruhn stresses the need for studies focusing on music processing.

Duke's (2000) review of research literature on the topic perhaps is the most comprehensive. He suggests that the popular press and some music educators have lost sight of what music education is about. He notes that research that fails to meet stringent standards of systematic inquiry, including replicability, statistical significance, and effect size, is not a credible basis for making a claim by simply saying "research has shown." Careful documentation is essential. Briefly put, Duke argues that the "Mozart Effect . . . has been observed in only a small number of published articles, has not been observed in other attempts to replicate these studies, and when observed, is very narrowly defined and very small in magnitude" (p. 12). His review of some 80 studies related to music and cognitive abilities, 37 of which were intervention studies, led him to the following conclusions:

(1) The so-called Mozart Effect has not been reliably observed; a number of investigators attempting to replicate the effect have failed to find evidence that music listening results in superior performance on tests of spatial reasoning.
(2) The limited evidence for effects of music listening and music instruction is confined to a very narrow and very specific type of cognitive task (even some tests of spatial reasoning fail to record any evidence of a Mozart Effect).
(3) The magnitude of the purported Mozart Effect, even when found to be statistically significant, is very small.
(4) The changes in scores on tests of spatial reasoning following music listening may be attributable to heightened attention or arousal, effects that may be produced by stimuli other than music.
(5) The so-called Mozart Effect, when observed, is not limited to the music of Mozart; for example one investigator obtained similar results with music performed by Yanni (the "Yanni Effect").
(6) Claims that music listening increases performance in any aspect of mathematics, chess play, or architecture (all of which have been mentioned in our literature) are as yet entirely unproven. (pp. 13–14)

Examination of several recent studies (e.g., Bridgett & Cuevas, 2000; Chabris, Steele, Bella, Peretz, Dunlop, Dawe, Humphrey, Shannon, Kirby, Olmstead, & Rauscher, 1999; Costa-Giomi, 1999; McCutcheon, 2000; Nantais & Schellenberg, 1999; Steele, Bass, & Crook, 1999; Steele, Brown, & Stoecker, 1999) seeking to replicate the Mozart effect has not revealed data that would refute Duke's conclusions. Seven years after the Mozart effect's debut, Shaw (2000), part of the original research team, insisted that music, spatial-temporal aspects of mathematics (but not language-analytic aspects), and chess are linked through the brain's ability to recognize symmetries; higher level brain functions employ identical cortical areas. Shaw also notes that misconceptions of the Mozart effect exist due to incomplete knowledge, and that research does not justify legislation. Yet, he believes that music "training" has value in and of itself as well as for improving learning ability. Time will tell if the Mozart effect becomes a historical curiosity or a useful procedure in narrow applications of learning theory.

Summary

This chapter's major points are:

1. Music that stimulates or arouses listeners has a strong energizing component.
2. For most people, music's energizing component is rhythm, particularly its attribute of tempo.
3. Sounds that are nonpercussive and legato characterize music that soothes, calms, or tranquilizes behavior.
4. Reviews of the limited research on the effects of stimulative and sedative music reveal differential response to the two types.
5. Music has been a part of ceremonies, particularly religious, military, and state ceremonies, throughout history.
6. People may use religious and other ceremonial music in ways rather different from those for which it was intended.
7. "Commercial" music involves using music in some way to make money directly from music or to enhance business through the use of music.
8. Background music, intended to be heard but not listened to actively, has individual uses as well as group uses.
9. The Muzak Corporation has been the most successful proponent and producer of background music.

10. Muzak's "stimulus progression" concept involves 15-minute segments of specially recorded instrumental music with increasing stimulus values from one composition to another as a result of changes in tempo, rhythm classification, instrumental grouping, and number of instruments.
11. Commercial uses of music include entertainment and background music in the workplace, the marketplace, and advertising.
12. Investigators have studied music in industry primarily in terms of its effects on employee productivity and morale.
13. Music serves two basic functions in the marketplace: arousal and pleasure.
14. Music in advertising should fit viewers' and listeners' inherent interests in and value for what is advertised.
15. Whether music attracts attention, reinforces a message, induces a mood, or simply entertains, the possibilities for music making a product or service more appealing arise from music's deep involvement in human culture.
16. Music as entertainment is intertwined inextricably with the popular music industry.
17. Although causality is difficult to establish, interactions exist between adolescents' listening habits and some of their socially undesirable behaviors.
18. Music may serve as narration because people have learned to associate acoustical events with real or imagined events in other sensory modes.
19. Fundamental principles of music therapy are that therapeutic experiences should (a) enhance the establishment or reestablishment of interpersonal relationships between a patient and others and (b) help foster the patient's self-esteem.
20. Two basic tools of music therapists are music's (a) power to stimulate or soothe activity and (b) values as a socializing agent and as a symbol or vehicle for expression.
21. Unkefer's taxonomy of music therapy programs and techniques for use when working with people with mental disorders includes six major categories: (a) music performing, (b) music psychotherapy, (c) music and movement, (d) music combined with other expressive arts, (e) recreational music, and (f) music and relaxation.
22. Standley's seven music therapy functions include the use of music to (a) serve as an audioanalgesic, anxiolytic, or sedative, (b) serve as a focus of attention and/or to structure exercise, (c) initiate and enhance therapist/patient/family relationships, (d) reinforce or structure learning, (e) stimulate auditorily and increase awareness of other forms of stimuli, (f) serve as reinforcer or structure for physiological response, and (g) structure pleasurable and positive personal interactions.

23. *Music medicine* and *performing arts medicine* are two new fields related to music therapy.
24. The use of music to facilitate nonmusical learning has received greatly increased attention during the past decade.
25. Due to commonalities of cortical processing, highly structured instrumental music similar to music of Mozart may ("may"–not "will") enhance spatial-reasoning skills in limited situations; this is the "Mozart effect."
26. Popular media, politicians, entrepreneurs, and other individuals with limited understanding of the Mozart effect have provided a classic example of going well beyond the data in claiming that Mozart's music raises intelligence; controversy will continue both in political and research arenas.

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Chapter 4

PSYCHOACOUSTICAL FOUNDATIONS

Psychoacoustics is a branch of psychophysics, the study of sensory responses to physical stimuli. To study auditory sensations is to study psychoacoustics. Questions regarding pitch and loudness comparisons, assigning pitch and timbre sensations to tonal clusters and other complex sounds, and, indeed, perceptions of all tonal properties essentially are psychoacoustical questions. Music, of course, is far more than a sequence of individual sensations. For 25 years or more, music psychology has had more interest in "holistic" processes of music cognition (e.g., melodic recognition, sensitivity to musical forms, rhythmic organization) than in more "atomistic" perceptual processes (e.g., individual pitch assignment, the time necessary for a vibration to become a tonal sensation, the intensity change necessary for one to just notice a change in loudness). Yet, psychoacoustical phenomena are essential building blocks for the more complex structures in time and auditory space from which people create music. Without psychoacoustical phenomena that translate physical phenomena into conscious sensations, music as we know it could not exist. The authors believe that detailed study of individual tonal perceptions and associated processes is valuable as part of understanding musical behavior.

After presenting brief overviews of the production and transmission of musical sounds and basic parts of the hearing apparatus, this chapter addresses the reception of musical sounds as psychoacoustical phenomena. The organization is in accordance with three basic psychological tonal properties: pitch, loudness, timbre. Duration, another basic tonal property, is encompassed within rhythm, the content of Chapter 5. Chapter 6 addresses the more global properties of melody and harmony, which build on psychoacoustical phenomena.

Production of Musical Sounds

Music is far more than physical movement, but it is partly that: Vibration–something moving back and forth–is basic to any musical sound. When the rate of vibration is within a certain range (neither too fast nor too slow), is generally periodic (i.e., vibrates with a regularly recurring motion), and is of

sufficient duration (20 to 50 msec or longer), people are likely to perceive the vibration as a *tone,* i.e., a sound heard with a definite pitch. Music also incorporates irregular vibrations, heard as noise.[1] Traditional vibration sources for musical sounds include strings, air columns, metal plates, and membranes. Much modern music employs vibrating electrical circuits, and adventurous musicians occasionally have exploited environmental sounds, such as bird calls, ocean waves, and industrial noise.

Consider a vibrating pendulum, one of the simplest illustrations of vibration and related properties. The pendulum, once displaced and thereby set into motion, will swing back and forth. Although the distance it swings will decrease gradually with time, the pendulum will swing long enough for an observer to note that it regularly returns to the point at which it began to swing. Every so often, with regularity, it completes a *cycle.* A cycle is the complete journey of a vibrating object from an original point, through both extremes of displacement, back to the original point. The time required for one complete cycle is the *period.* The number of cycles completed in a given amount of time is the *frequency.* The distance between the pendulum's original location and its point of maximal displacement in either direction is the displacement *amplitude.* One readily can observe and describe a cycle, period, frequency, and amplitude in relation to a vibrating pendulum.

Although a person cannot see (except with stroboscopic lighting or a measuring instrument such as an oscilloscope) the individual cycles of vibrating objects producing musical sounds because they vibrate too fast, those objects also vibrate in cycles, with periods, frequencies, and amplitudes. Most musical sounds, tones and noises, are a complex of individual vibrations; they contain numerous frequencies and vibration patterns. Musical sounds can be analyzed into component frequencies, but a listener usually hears a tone as having one distinct frequency.

Not all vibrations are perceivable as sound. A minimum amount of power (intensity) is necessary, and human ears normally respond to an approximate frequency range of 20 to 18,000 cycles per second (called Hertz, abbreviated Hz, in honor of Heinrich Hertz (1857–1894), who conducted early research with electromagnetism). Individuals vary in their frequency sensitivity, particularly regarding the upper limits. Sounds considerably lower than 20 Hz may be heard under artificial conditions.

The production of musical sounds, then, requires that something be set into vibration. If it vibrates with acceptable frequency and intensity and those vibrations somehow can be transmitted to a listener, music may be possible.

[1]"Noise" may be considered as sound that lacks definite pitch, or simply as unwanted sound. In music, cymbal crashes and snare drum rolls exemplify "wanted" musical sounds which are "noise" by the pitch criterion.

Transmission of Musical Sounds

Transmission, as used here, refers to the *propagation* or spread of a disturbance through the air from a sound source to a listener. We are not considering electrical or electronic transmission or sound's travel through media other than air.

Just as a pendulum helps one visualize vibration properties, a row of upright dominoes helps one visualize transmission. If they are spaced at a critical distance from each other, a person can produce an amusing ripple effect by pushing the first domino into its neighbor, which then will fall into its neighbor, which then will fall into *its* neighbor, etc. The ripple spreads over the chain of dominoes as each one collapses. This ripple spread is somewhat analogous to what happens when a disturbance spreads through the air from a sounding musical instrument or voice to a listener. The vibrating body disturbs air particles around it. Those particles bump other particles, which in turn bump others. Unlike the dominoes, each particle can move back and forth, as a miniature pendulum, as long as the disturbance's source continues to vibrate. However, just as the first domino does not travel to the end of the row, no one air particle travels from the musical source to the listener. The *disturbance* travels.

A disturbance spreading through the air is a *longitudinal* disturbance, i.e., the overall disturbance travels in the same direction as the slight movements (displacements) of each particle. (In *transverse* disturbances, which can not occur in air, the overall disturbance travels in a direction perpendicular to the slight movement of each particle.) A travelling disturbance or a chain of successive travelling disturbances often is called a *wave.* A sound wave is a series of disturbances travelling through a medium.[2]

Waves may travel directly from a sound source to a listener. They may encounter a surface which represents a sudden change in properties of the medium; then, the wave *reflects,* although some of its energy is absorbed by the reflecting surface. Reflection is a sudden change in the direction of wave travel; a gradual change in direction is *refraction,* a progressive "bending" of the wave resulting from a gradual change in medium properties, such as temperature or density. People may sense sounds from sources not directly aligned with their ears or obscured from view because of *diffraction,* a wave's ability to "go around corners" or pass through a small opening.

A travelling wave in air comprises changing locations of air particles as they undergo bumping and the resulting displacements. Changes in air pressure accompany the continual changes in particle location. When particles are compressed more closely together than they are in an undisturbed state,

[2]Unlike light waves, radio waves, and other electromagnetic disturbances, sound waves must exist in an intervening physical substance. Light can travel through a vacuum; sound can not.

the pressure increases. When particles are spread further apart (rarefacted) than they are in an undisturbed state, the pressure decreases. The systematically alternating moments of compression and rarefaction mean that periodic pressure fluctuations occur at any point in a travelling wave in air. Such periodic pressure fluctuations, tiny though they are, are the form in which Beethoven symphonies, Handel oratorios, rap creations, and third grade recorder sounds reach our ears.

Reception of Musical Sounds

From Air to Inner Ear

The periodic pressure fluctuations accompany the travelling wave as it enters the ear. The obvious external or cosmetic portion of the ear is the *pinna;* the "hole in the head" is the entrance to the *auditory canal* or *meatus,* a tube that is approximately 2.54 cm long. The travelling wave passes through the auditory canal and encounters the *eardrum* or *tympanic membrane,* which separates the outer and the middle ear. Resonance, particularly in the approximate frequency range 2000–3000 Hz, may increase the sound pressure that the wave exerts as it travels through the auditory canal (Pickles, 1982, pp. 12–13); the ratio of sound pressure at the eardrum to sound pressure at the opening of the auditory canal is greatest around 3000 Hz (Mathews, 1999b, p. 4).

The eardrum responds to the pressure fluctuations by moving in and out, somewhat like a drumhead. (Incredibly tiny amounts of pressure change are sufficient to move the eardrum.) Eardrum motion is more efficient when the air pressure is equal on both sides of the eardrum; the air supplied through the *Eustachian tube,* connecting the back of the throat to the middle ear, assists in the equalization. A chain of three tiny middle ear bones or *ossicles* (in succession, the hammer, anvil, and stirrup, or the malleus, incus, and stapes) connects the eardrum to another membrane, the *oval window,* which separates the middle and inner ear. This bone action is extremely important because hearing sensitivity would be compromised severely if the sound wave as it exists in an air-filled environment were transferred directly to the fluid within the inner ear (Durant & Ferraro, 2000). The *acoustic reflex,* resulting from the contraction of two muscles (tensor tympani and stapedius) connected to the ossicles, may increase the bones' stiffness and thereby help protect the inner ear from damage due to strong sounds.

The oval window is the travelling wave's point of entry to the snail-shell-shaped *cochlea,* part of the inner ear. The cochlea contains three major fluid-filled chambers. The *scala tympani* stretches from the oval window to the far end (apex) of the cochlea. The *scala vestibuli* runs from another membrane,

the *round window,* to the apical end, where a small opening called the *helicotrema* connects the scala tympani and scala vestibuli. Running between the other scalae is the *scala media,* closed at both ends (Mathews, 1999b, p. 5). The scala media is contained within the *cochlear duct,* an appendage which is connected to the cochlear wall near the oval window. Running along one side of the duct is the *basilar membrane.*

The ossicles' stimulations of the oval window create wavelike movements through the fluid contained within the scala tympani and scala vestibuli; as the oval window moves one way, the round window moves another way. The travelling wave in the cochlea is quite different from the original sound wave; as Yates (1995, pp. 49–50) indicates, cochlear fluid waves are more like ocean waves than sound waves in air.[3] As the wave sweeps through the fluid, the basilar membrane detects the fluid movements and in turn moves up and down in a manner which depends on the movement frequencies. Higher frequencies elicit maximal membrane movement closer to the oval window ("near" or basal) end; lower frequencies elicit maximal movement closer to the helicotrema ("far" or apical) end. Combinations of frequencies, such as most musical tones, excite the membrane at several locations. This is the beginning of frequency discrimination, as the original rapid vibrations and their variations are converted into sets of information about particular frequency ranges (Yates, 1995, pp. 43–44). Where, when, and how much the basilar membrane is excited provide basic information for perception and organization of the psychological sensations into music.

From the time the original vibrating body disturbs the surrounding medium until the resulting disturbance excites the basilar membrane, mechanical energy transmits the sound signal as a matter of movement. Now the means for signal transmission changes. Lying alongside the basilar membrane are *hair cells* (*audiocilia* or *stereocilia*), collectively known as the *organ of Corti,* which sense the membrane's movements and function as *transducers.* A transducer is a device which converts one form of energy to another (common examples include microphones and loudspeakers); the hair cells convert mechanical to electrochemical energy and start auditory signals on their way to the brain.

[3]Although water waves occasionally are used to demonstrate various aspects of sound waves, especially propagation and wave phenomena such as reflection and diffraction, waves in water are more complex. For one thing, since water is a dispersive medium while air is a nondispersive medium, the speed with which the wave travels varies with frequency in water, while wave frequency and speed are independent in air. As Yates indicates, cochlear wave speeds are not independent of frequency. Furthermore, while waves in air are always longitudinal, water waves are a mixture of longitudinal and transverse motion. Further complication regarding ocean waves arises due to differences in behavior between deep and shallow water!

From Inner Ear to Brain

The basilar membrane's characteristic vibration innervates (excites) the hair cells, particularly as the membrane moves toward the center of the cochlear duct. Estimates vary regarding the exact number of hair cells. According to Moore (1989, p. 26), there are about 25,000 *outer* hair cells, each containing about 140 hairs and arranged in three rows, and about 3500 *inner* hair cells, each containing about 40 hairs (stereocilia). (Outer and inner refer to location in relation to the outside of the cochlea.) Lambert and Canalis (2000, p. 54) speak of 15,500 hair cells, arranged in an inner row of 3500 cells, with the outer cells in three or four rows. Outer cells have 50–150 stereocilia per cell; inner cells have about 120. The outer cells are more sensitive and respond at lower sound levels than the inner cells. The hair cells differ functionally, as evidenced by the guinea pig's inner cells producing a cochlear microphonic (an electrical discharge obtained by inserting an electrode into the cochlea) proportional to the *velocity* of basilar membrane movement while outer cells produce a cochlear microphonic proportional to the amount of basilar membrane *displacement* (Dallos et al., 1972).[4]

No one hair cell can encode an entire cochlear waveform; even repetitious pulses of individual neural firings are insufficient (Mathews, 1999a, p. 16). Even a single-tone stimulus activates a large portion of the cochlear neural fibres; two slightly differing tones activate respective areas along the basilar membrane that overlap considerably. The boundaries between activated and unactivated areas apparently help signal stimulus frequency(ies). Intensity apparently is signalled in terms of the number of activated fibres and the frequency of neural discharge (Whitfield, 1967). The basic information regarding frequency, intensity, and waveform properties is passed to and through the afferent neural pathways to the brain's auditory cortex, in rough accordance with the schematic diagram in Figure 4-1 (Roederer, 1995; Whitfield). Although the auditory cortex is the sound stimulus's "ultimate destination," neural processing occurs prior to the cortex; some perception necessary for basic musical decision making is completed at subcortical levels. Research with cats and monkeys suggests that neurons in the auditory pathway respond preferentially to various stimulus aspects, including frequency, duration, and rapid transient properties such as those which characterize tonal beginnings; so, although details remain sketchy, a subcortical mechanism for clarifying and enhancing tonal features apparently exists (Moore, 1989, pp. 30–41).

Afferent and *efferent* neural cochlea-cortex pathways exist. Afferent fibres, which send pulses toward the brain, innervate the inner hair cells. Efferent

[4]According to Durant and Ferraro (2000, p. 99), inner hair cells make some response to basilar membrane displacement, but it is slight in comparison to the velocity.

fibers, bringing neural pulses from the brain, innervate the outer hair cells (Mathews, 1999a, p. 13). According to Zwicker and Fastl (1990, p. 24) and Wallin (1991, p. 155), more than 90 percent of the afferent fibres make contact with inner hair cells; Lambert and Canalis (2000, p. 62) say 95 percent. The efferent pathway, while directed toward the outer hair cells, evidently enables the brain to modify the excitability of the hair cells, especially the inner hair cells (Davis, 1962; Pickles, 1982, pp. 31–32). Zwicker and Fastl (1990, p. 30) discuss interaction between the two types of hair cells.

The afferent pathway includes afferent first-order and second-order neurons (within the spiral ganglion), the superior-olivary complex, the lateral lemniscus, the inferior and superior colliculus, the medial geniculate body, and projections of the auditory cortex (Newman, Storper, & Wackym, 2000). The efferent pathway includes higher descending neurons and the olivocochlear bundle (Gacek, 1972). While the neuroanatomy may be obscure to most people, the afferent pathway is important musically, because that is how information travels to the place where the listener organizes the information into music. The efferent pathway is important because it provides a pathway for the brain to "alert" the cochlea for particular sounds.

The above abbreviated description of a sound's travel, as a pressure fluctuation and as an electrochemical discharge, from a source to a listener's brain may help the reader appreciate some of the structures involved. Figure 4-1 presents a schematic diagram of the path of travel. The classic Stevens and Warshofsky (1965) text offers a highly readable and profusely illustrated description. Lambert and Canalis (2000) provide extremely detailed functional and physiological descriptions of the ear's anatomy. Newman, Storper, and Wackym (2000) present the eighth cranial nerve (the auditory nerve) in great detail.

Hearing, of course, is more than the operation of the structures and the neural processes. As Espinoza-Varas and Watson (1989, p. 68) note, "hearing" in the sense of extracting sensory information and making sense of it is an active brain function, which depends on skill, experience, learning, and memory.

Pitch Phenomena

Pitch pervades most music. Unfortunately, the term may be ill-defined and confused with other phenomena. Usually, pitch refers to a tone's apparent location on a high-low continuum. Placement on that abstract continuum in relation to other pitches is learned. In the usual sense, pitch is a *metathetic* variable, a variable of apparent place or location, rather than a *prothetic* variable, a variable of apparent strength or size (Stevens, 1975). The word "apparent" is important because pitch represents a psychological judgment

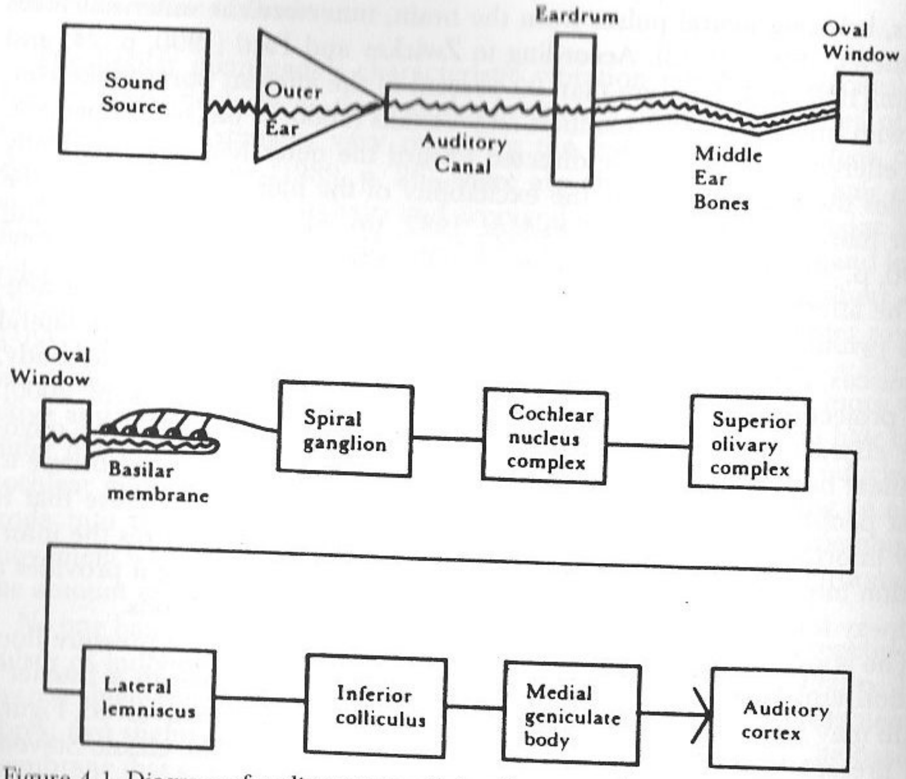

Figure 4-1. Diagram of auditory transmission from sound source to auditory cortex.

of how a physical aspect of a tone "appears" as a sound.

Shepard (1999) notes that pitch has a spatial structure, as is appropriate for a metathetic variable. Just as visual space, pitch is a medium which can bear forms. Pitch is a *morphophoric* medium. One can move a geometric figure in space, and it will remain that same figure. Similarly, one can transpose a phrase or melody and the pattern of successive pitches will retain its identity because the relative apparent locations of the tones in relation to each other will remain the same.

Pitch has other aspects than apparent location. One prothetic aspect is *definity,* the ease with which a pitch may be matched. For example, a flute usually has a far more obvious and "definite" pitch than a bass drum. Rakowski (1979) calls this definity property pitch strength and suggests measuring it by the variability of subjects' attempts at matching pitches in question to standards. Another pitch aspect, albeit one that is largely meaningless as an isolated tone, is *intimacy, circularity,* or *similarity.* When individual pitches occur in a sequential tonal context, as in a melody or theme, the similarity of any two pitches varies in accordance with tonality (Krumhansl, 1979).

Under unusual laboratory conditions involving very specially arranged combinations of frequencies and amplitudes within synthesized complex tones, pitch's height aspect can be suppressed completely in favor of the circularity aspect. A succession of such tones seems to continually ascend or descend, rather like an endless circular staircase (Shepard, 1964, 1982).

The following discussion of pitch phenomena is organized around clarification of pitch's relationship with frequency, pitch processing for simple and complex tones, phenomena resulting from pitch combinations, absolute pitch, and attempts to measure pitch.

Frequency-Pitch Relationship

Frequency, the vibration rate, usually expressed as cycles per second or Hertz, is a physical property of tones; it would exist independently of any human observer. Pitch, a sensation, is a psychological property that requires a human observer. The two properties are not identical: One should not call frequency pitch or vice versa. To further complicate things, the frequency-pitch relationship is not in any perfect correspondence.

In general, people may experience a pitch sensation from any sufficiently periodic vibration in the range of approximately 20 to 18,000 Hz. The upper limit varies widely among individuals. Many people experience a progressive loss of sensitivity to higher frequencies as they age; this condition, called *presbycusis,* appears to result from an interaction of noise, heredity, and neural degeneration. Presbycusis is a growing problem in industrialized societies: In the United States, about 40 percent of the population over age 75 is affected. Especially in men, where it is more common than in women, presbycusis may begin to appear around age 30 (Sajjadi, Paparella, & Canalis, 2000).

Under special conditions, the lower limit may be reduced: Whittle, Collins, and Robinson (1972) successfully presented highly intense frequencies as low as 3.15 Hz to subjects seated in a cabinet in such a manner that their entire bodies were immersed in uniform sound pressure. The musically useful range of basic frequencies is well within the sensory limits; when tuned to the international frequency standard (A_4 = 440 Hz), the frequency range of the standard piano keyboard is from 27.5 to 4186 Hz. Of course, to experience the full range of musical timbres, hearing well beyond 4186 Hz is essential.

Pitch varies largely as a function of frequency variation, but each minute frequency change does not necessarily elicit a pitch change. Classical psychophysics developed a concept of the *just noticeable difference* (jnd) or *difference limen,* an amount by which a stimulus must change in the appropriate physical property in order for an observer to detect a difference in sensation

a certain criterion percentage of the time. The jnd for frequency discrimination (and hence detection of discrete pitches) varies greatly with methodology as well as with people (Woodworth & Schlosberg, 1965); the jnd's size varies with the stimulus frequencies such that it is smaller (in terms of Hz) for lower frequencies (Moore, 1974; Nordmark, 1968). Despite its fluctuation, the jnd usually lies well within the limits necessary for functional musical discrimination. Its exact size is rarely of any musical importance.

Pitch may vary without any change in frequency. Although the effect is rather idiosyncratic and more likely to occur with tones of just one frequency than with typical musical tones, a tone which increases in intensity may be heard as rising or falling in pitch while also becoming louder (Stevens, 1935; Terhardt, 1974b). In *binaural diplacusis,* the listener hears a tone with a different pitch in each ear. Difficult to research because of its transient nature, the relation of binaural diplacusis to music processing is usually not critical (Sherbon, 1975), although in some clinical instances it may play a role in music perception. For a music teacher or therapist, perhaps the most important consideration regarding diplacusis is that the condition *can* occur–the student or client who insists that "it sounds different in each ear" is not necessarily hallucinating!

Pitch Processing of Single Pure Tones

A "pure" tone, also called a sine tone or a sinusoidal tone, contains exactly one frequency. Except for some electronic sounds, there are no pure tones in music, although certain flute and organ tones come close to being pure. A good tuning fork settles into a sinusoidal tone after the initial "clang" dissipates. Most musical tones are complex; even though they usually are heard as having one pitch, they contain a mixture of frequencies. Nevertheless, knowledge of pure tone processing is useful because all complex tones may be analyzed into pure tome components, and investigators have learned much about the auditory system with the aid of pure tones.

Pure tones, limited to one frequency, actually are less clear in pitch than complex tones. For a given duration of sound, a high frequency tone can be judged with greater accuracy than a low tone. A certain minimal amount of time is necessary for pitch perception of a given frequency; the greater the frequency, the shorter that time period may be (Kock, 1935).

The place of greatest stimulation along the basilar membrane basically is responsible for pure tone pitch perception. Research (Roederer, 1995; Stevens, Davis, & Lurie, 1935; von Bekesy, 1960; Zwicker, Flottorp, & Stevens, 1957) indicates that stimulations must differ by a certain amount in order for an observer to detect that two separate tones clearly differ, or that a continuously sounding tone varying in frequency has changed enough for an observer to detect a pitch change. That amount is the *critical band width* (cbw); it is not a precise unchanging value but varies with frequency, intensity, duration, and rate of change.

Pitch Processing of Combined Pure Tones

Tones which contain only one frequency when they leave their respective sound sources may combine in the air and reach the ear in the form of a tonal superposition; a sound wave is shaped by the interaction or interference of each component wave. Any sound wave, in the sense of a pattern of displacements, is determined at any given time by each component's frequency and intensity. When there is only one component, as in a pure tone, the wave simply is dependent on that tone's frequency and intensity. A combination of pure tones creates a superposed waveform, which depends not only on frequency and intensity but also on relative phase.

Phase is the portion of a vibration cycle that is complete at a particular time. Just as the moon may appear as new, a quarter crescent, half, full, or elsewhere at predictable times, a vibrating particle may be at its original position or displaced by varying amounts in either direction. Two vibration cycles of identical frequency may or may not be in phase. Each may start its individual cycle at the identical time, in which case they are at zero phase or "in phase" relative to each other. One may start later and remain a constant phase behind the other; e.g., whenever one vibration cycle is at its point of maximal displacement, the other is at the original point of rest. In this case, they are "out of phase." Relative phase influences the superposed waveform. A combined waveform may have less displacement amplitude than either component waveform because of the *destructive* interference that results from the individual components, in effect, working against each other. Of course, the combined waveform will be stronger than either component when the components are in phase and *constructive* interference results.

A combination of pure tones will stimulate the basilar membrane strongly at more than one location. If the frequency difference (Δf) between the tones is sufficiently large, the combination is clearly heard as two separate simultaneous tones. If Δf is insufficient, i.e., the cbw is not reached, a sensation of roughness, beating, or, if $\Delta f = 0$, unison will result. In terms of frequency separation, Δf may vary from approximately 25 to 2000 Hz, although studies inevitably give different results (Moore, 1989; Plomp, 1976). One estimate of the actual linear distance along the basilar membrane associated with Δf is 1.2 mm (Roederer, 1995, p. 36).

Thus, frequency discrimination of two simultaneously sounding pure tones also is primarily dependent on the location of basilar membrane stimulation. The jnd for frequency discrimination of two simultaneous tones is

considerably larger than the jnd for detecting changes in a single pure tone of varying frequency (Roederer, 1995). However, musicians rarely deal with pure tones.

Pitch Processing of Complex Tones

A complex tone contains more than one frequency. It differs from a combination of pure tones in that the waveform from *one* sound source is complex. A bowed violin string, a plucked guitar string, a blown trumpet, and a human voice all output a complex waveform which is a mixture of individual frequency components, all of which arise from the source's complex vibration pattern and interact to determine the complex waveform. Even though the complex tone contains multiple individual frequencies, the listener usually perceives the tone as having one distinct pitch sensation.

There are exceptions to the one-sensation norm. Some wind instrument players can produce *multiphonics,* i.e., tones which are a mixture of simultaneous individual sounds where no one pitch is dominant. (While some novice flute, clarinet, and saxophone players produce multiphonics quite accidentally, the deliberate use of multiphonics is a carefully acquired skill!) The biphonic or "throat" singing style of Tibet and other Central Asian locations is a carefully developed musical use of complex tones where there is more than one pitch sensation. Known as Xöömij, Khoonei, or Xoomi, the style features a high melody pitch and a simultaneous low drone pitch. The high pitch apparently is due to resonance in the rear of the vocal tract; this explanation currently is favored over any double sound source theory, thereby maintaining the idea that there is one complex tone, without one dominant pitch sensation (Adachi & Yamada, 1999).

The complex tone's individual frequency components include a *fundamental* frequency (generally the lowest frequency) and higher frequencies, which may be in a harmonic or an inharmonic relationship. In a harmonic relationship, all higher frequency components are in an integral multiple relationship with the fundamental; i.e., nondecimal whole numbers multiplied by the fundamental frequency will give the frequencies of the higher components or *harmonics.*[5] In an inharmonic relationship, the higher components are related in a nonintegral multiple manner. Musical complex tones show varying degrees of harmonicity. The more nearly harmonic the relationship, the more obvious may be the pitch sensation, although the auditory system really is quite robust in detecting a definite pitch sensation despite a certain degree of inharmonicity. In addition to harmonicity, attack time, the shape of the individual wave components across time (envelope), and vibrato rate influence the definity of the complex tone's apparent pitch (Sethares, 1998, p. 26).

The relative strengths of the particular frequency components vary. Diagrams of complex tones' tonal *spectra,* obtained with the aid of spectrum analyzers or other analytic equipment, show, within limits, the particular component frequencies and their intensity levels. Curiously, the fundamental frequency is not always the strongest (most intense) component, despite the fact that the pitch ascribed to the complex tone almost always is the pitch elicited by the fundamental.

A complex mixture of frequencies may stimulate the basilar membrane at eight or more locations; the stimulations often exceed the critical band width. Yet a complex tone usually is heard with one distinct pitch. Why? The basilar membrane serves as an analyzer and information passer for complex tones–the pitch assignment occurs higher in the auditory pathway.

Pitch perception of complex tones is based on the auditory system's ability to use information regarding the pattern of stimulation–placewise, timewise, or both. The complex sounds to which people are able to assign a definite pitch sensation are periodic, or nearly so: The wave patterns recur regularly as the vibration causing the sound continues.[6] The simplest kind of periodic wave (a sine wave) arises from a sound source vibrating at just one frequency (a pure tone); a diagram appears in Figure 4-2. (Wave diagrams such as this, similar to oscilloscopic traces, should be conceived as particular displacement patterns frozen in time.) A complex periodic wave appears in Figure 4-3. In each case, there is a recurring pattern. Sooner or later, the waveform will repeat itself; it has *periodicity.*

The particular structure of the recurring pattern and the rate at which it repeats are extremely important musically. In their extensive discussion of what they believe to be cross-cultural musical "universals," Carterette and Kendall (1999, p. 781) identify two basic principles that enable categorization of the world's sensations and perceptions. One principle is environmental contrast: Differences, boundaries, and changes provide vital information. The other is periodicity, by which people search for recurring patterns and temporal and spatial redundancies. Recurring vibration patterns and redundancies within them are the basis for complex tone pitch detection.

[5] Unfortunately, the labelling of tonal components is inconsistent: partial, harmonic, and overtone are used interchangeably, albeit erroneously. A *partial* is any component of a complex tone, regardless of any mathematical relationship or lack thereof. A *harmonic* is any frequency (not necessarily a component of a particular tone) in an integral multiple relationship with the fundamental. (The fundamental itself is the first harmonic; f × 1 = f.) An *overtone* is any harmonic *other than* the fundamental which is in a particular complex tone. Any component of a complex tone is a partial; it may or may not be a harmonic. Any integral multiple of the fundamental is a harmonic; it may or may not be a partial or an overtone (Backus, 1977).

[6] The technical and more restrictive definition of a periodic vibration is that all the frequency components are related harmonically.

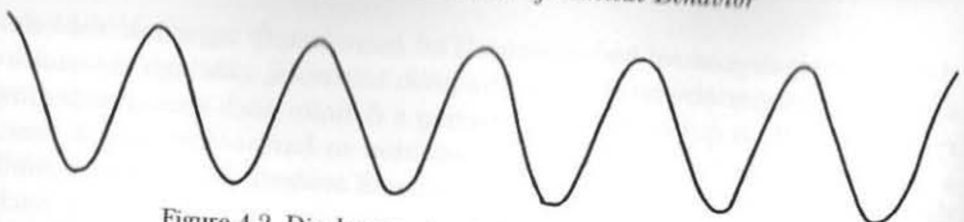

Figure 4-2. Displacement pattern arising from pure tone.

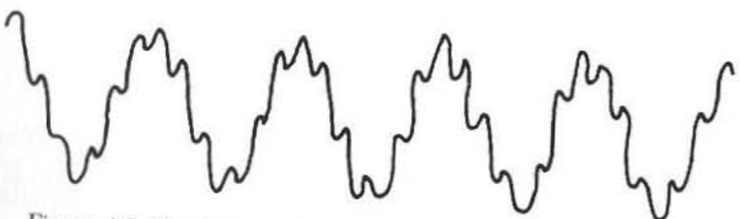

Figure 4-3. Displacement pattern arising from complext tone.

From basilar membrane activity, the auditory system gleans *place* or *spec-tral* information (where and to what degree the particular stimulations occur) and *temporal* information (the rate at which stimulations recur). Place information is available over the entire auditory range. Temporal information is available only to about 5000 Hz and would seem to be especially important for musical pitch because musical pitch generally is lost for pure tones above 5000 Hz: Sequences of really high tones are difficult to organize as melody (Moore, 1989, p. 191).

A complex tone's usually obvious pitch sensation (some people can hear out individual components, and biphonic singing and instrumental multiphonics, mentioned above, defy unitary pitch sensation) is known as low pitch, periodicity pitch, virtual pitch, residual pitch, and subjective pitch. *Low pitch* probably is the term which is most free of semantic difficulties arising from particular theories or other phenomena. Low pitch perception is not understood thoroughly; two broad classes of models are the *pattern recognition* and *temporal* models.

In pattern recognition models, the auditory system derives low pitch from neural signals which correspond to the primary basilar membrane stimulations. Resolution of the separate components of the tonal *spectrum* (the combination of particular frequencies and their relative strengths) is crucial. Pattern recognition models have difficulty in accounting for low pitch detection in situations where harmonic relationships are especially complex and frequency components are too high to be resolved (Moore, 1989, pp. 168–171).

Shamma and Klein (2000) offer a pattern recognition model for low pitch detection that suggests that any sound of widely varying simultaneous frequencies, even noises, can generate neural "templates" which, once learned, provide a basis for comparison and auditory decision making. Two stages comprise their model. In a cochlear filtering stage, input to the auditory nerve is analyzed and enhanced to resemble a synchronized response of cells in the cochlear nuclei. In a coincidence detection stage, responses from characteristic neural firing frequencies are compared across the input channels. Over time, coincidences accumulate, thereby forming harmonic templates to which incoming frequency combinations may be compared. Essentially, the Shamma and Klein model appears to involve learning robust harmonic approximations which help identify and assign pitch to a wide range of complex tones.

In temporal models, low pitch is elicited by the time interval between recurring aspects of the overall pattern, such as the time between waveform peaks. Through a neural process called *fundamental tracking,* a wave's repetition frequency can yield the overall low or periodicity pitch sensation. (For example, a complex tone with components of 50, 100, 150, 200, and 250 Hz will make a wave with an overall repetition frequency of 50 Hz, as will a complex tone with components of 450, 500, and 550 Hz. In each case, the fundamental tracking mechanism yields the pitch sensation corresponding to 50 Hz.)

Temporal models can not account for situations where tonal components do not interact in either ear. Such noninteraction is illustrated by the classic Houtsma and Goldstein (1972) study where, using earphones, the investigators presented randomly chosen paired upper harmonics, without the fundamental monotonically (both harmonics to one ear) and dichotically (one harmonic to each ear) to three experienced musicians. The musicians could recognize melodies formed by the "missing" fundamentals in both conditions, even though the harmonics could not combine in either ear in the dichotic condition. Fundamental tracking is a *central* (in the neural network) rather than a *peripheral* (in the cochlea) process.

Given pattern recognition models' difficulties in accounting for harmonic complexities and temporal models' difficulties in accounting for fundamental tracking of dichotic signals, as well as the fact that adherents of both schools of thought can describe situations where their respective models apply, one logically might seek a model that incorporates aspects of both model classes. One such model is Moore's (1989, pp. 183–187) five-stage comprehensive model; the authors believe that it remains one of the most comprehensive and logical models of complex tone pitch detection.

Moore's first stage is analogous to a series of overlapping filters which pass through and/or modify certain aspects of stimulus information. Filters responding to low frequency components resolve individual components and output simple waveforms. Filters responding to high frequency components output complex waveforms, which are based on the interaction of sev-

eral components and have repetition rates corresponding to the complex stimulating waveform.

The second stage involves transduction (energy conversion). Neurons fire in accordance with basilar membrane motions to represent the waveform's temporal structure. Particular neurons are "driven" by the waveform's frequency components that are near the neurons' "characteristic frequencies" or frequencies at which the neurons are most likely to fire.

The third stage analyzes the times between firings of each neuron. Then, the fourth stage compares all those times and searches for common time intervals.

In Moore's final stage, a decision stage, one time interval is selected from the array of intervals yielded by earlier stages. The perceived pitch of the complex tone then is the pitch elicited by the reciprocal of the selected time interval. (Frequency, the number of vibration cycles in a designated time, and period, the time required for one complete vibration cycle, are related reciprocally, e.g., a frequency of 100 Hz and a period of 1/100 sec are reciprocals of each other.)

Moore's model predicts that lower frequency components dominate the pitch assignment process: Information for the lower components is less ambiguous than for the higher components since the lower components are more likely to have distinct individual waveforms, in accordance with the model's first stage. Research (Plomp, 1967b; Ritsma, 1970), however, suggests a *spectral dominance,* in which the components mainly determining the complex tone's pitch vary with the fundamental frequency. In general, the lower the fundamental, the higher the component numbers of important components. The degree of any component's dominance may vary as a function of the component's strength in relation to neighboring components (Moore, Glasberg, & Peters, 1985).

The details of complex tone pitch perception are intricate and under continual investigation. The detection process is quite robust: Even tones with significant amounts of inharmonicity and tones with relatively few frequency components may elicit a clear sensation of one pitch. Musical settings add further complications. Sethares (1998, p. 36) stresses that tonal context influences low pitch; the auditory system "hears" what makes the most sense within the particular sound environment. A logical sequence of pitches, as in a melody, may make particular individual tone pitch assignments preferred over others.

Discussion of complex tone pitch perception may appear rather arcane: Most musicians and many students of musical behavior are not particularly concerned with the process by which low pitch assignment occurs. Nevertheless, they should recognize and appreciate that tonal music as we know it could not exist without the intricate neural processes involved; people would be limited to pure tones or continual harmony.

Combination Tones

A complex tone's pitch usually is a single pitch sensation for one tone, from one sound source. The *combination tone* is a third or "extra" tone sensation arising in the presence of two *different* simultaneous tones, which may be pure or complex. For example, one may experience combination tones while listening to a well-tuned violin double stop, a simultaneous (harmonic) organ interval, or two sopranos singing a well-tuned interval. In addition to the two deliberately produced externally sounding primary tones, an observer hears the "extra" sensation. Usually, combination tones with a frequency equal to the difference between the two primary tone fundamental frequencies ($f_2 - f_1$, "difference" tones) are the easiest to hear. Higher-order combination tones such as $2f_1 - f_2$ and $3f_1 - 2f_2$ also may be audible. Theoretically, many other combinations resulting from multiples of the lower tone (f_1) and the upper tone (f_2) are possible.

A true combination tone is not present in the external sound stimulus, although the listener perceives it as if it were present (Rasch & Plomp, 1982). A combination tone differs from the very strong "extra" sound which one may obtain by feeding two outputs from a synthesizer, electronic organ, or two oscillators into one speaker. In those cases, the "extra" frequency (which often is equivalent in Hz to a difference tone) is an electronic artifact resulting from heterodyning, in which two signals mix and fluctuate in amplitude (Strange, 1972). The distortion product produced by heterodyning is physically present in the external sound stimulus, unlike a combination tone.

A true combination tone results from nonlinear cochlear distortion, i.e., a tendency for the basilar membrane to move more than can be accounted for by the auditory stimulus. The primary stimulus tones must be at a sufficient intensity level (Plomp, 1965), and audibility of combination tones will vary greatly with people and particular frequency combinations (Plomp, 1976). Research with guinea pigs and monkeys clearly shows that the type of distortion necessary to produce combination tones by in effect causing extra hair cell stimulation at different places is possible (Dallos & Sweetman, 1969; Rhode & Robles, 1974). Rasch and Plomp (1982) refer to cochlear distortion as "nonlinear transmission."

Goldstein (1970) demonstrated that a "cancellation tone" of identical frequency, adjusted for amplitude and relative phase, could cancel a combination tone due to destructive interference.[7] In principle, the cancellation tone is similar to noise quelling devices where a person wears a headset that out-

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[7]Interference is the result of adding waveforms. If the combined waveform has greater amplitude than the individual components, the interference is constructive. If the combined waveform has less amplitude than the individual components, the interference is destructive. Waves of identical frequency, but opposite phase, will cancel each other in totally destructive interference.

puts signals in opposite phase with frequencies in designated ranges. (Of course, the undesirable noises are environmental sounds, not combination tones.)

Combination tones are special musical phenomena, limited to situations where the primary tones are sufficiently loud and in tune. Since they can interact with physically present parts of the sound to increase tonal complexity, they may alter the way in which a listener experiences a tonal stimulus. They may have some musical utility in "enriching" a sound.

Intervals

An interval is a simultaneous or successive sounding of two tones. Musicians often call a simultaneous interval harmonic and a successive interval melodic. Isolated interval phenomena of interest to the psychology of music include consonance, apparent pitch, and interval size. Lengthier sequences of intervals form musical phrases and melodies.

CONSONANCE-DISSONANCE. Historically, varying uses of the terms as well as different views of what determines an interval's classification have confused the study of consonance and dissonance. A simple consonance = pleasant or restful, dissonance = unpleasant or strident labelling scheme is inadequate. Equating certain tunings with consonance, Peterson and Smith (1930) asked subjects to evaluate mistuned intervals and report "unnatural" ones. Bugg (1933) reported that subjects were confused when asked to classify intervals on the basis of fusion, smoothness, blending, and purity (all of which have nonauditory connotations) as if the characteristics were synonymous. He felt that consonance is not necessarily a pleasantness-unpleasantness dimension; affective reactions to intervals somehow should be removed from actual consonance judgments. Over 40 years later, Terhardt (1974a) divorced *psychoacoustic* consonance (the absence of "roughness") from musical interval sensations: Psychoacoustic consonance is a matter of frequency distance, whereas musical intervals are ratio phenomena. Difficulties with consonance theories and judgments are related to psychologists' and musicians' inabilities to agree regarding a single working definition.

Perhaps a single definition is impossible due to the complexities of musical context. Tenney (1988) recognizes five varieties of consonance and dissonance. In *melodic consonance,* the melodic context of successive (melodic) intervals determines the interval's classification. *Polyphonic consonance* is the pleasantness-unpleasantness, restful-strident aspect of simultaneous intervals. In counterpoint, where simultaneous horizontal movements of musical lines may override vertical sound structures, the voice leadings influence a *contrapuntal consonance. Functional consonance* is how an individual tone relates to a tone within a chord, usually the "tonic" or "home tone": A matter of movement rather than unpleasantness, functional dissonance presumably causes chordal motion. Beating among the partials of simultaneous tones influences *sensory consonance.*

Despite semantic difficulties and aspects of musical context, musicians generally regard *musical consonance* as a relatively restful and passive auditory sensation, while dissonance is a relatively agitated and active state. Seconds, the augmented fourth, and sevenths currently are considered dissonant in an abstract sense; unisons, thirds, fourths, fifths, and octaves are considered consonant.[8] Such judgments can change with time and context, and Lundin (1947) proposed what remains as the most espoused explanation of musical consonance: It is a matter of cultural conditioning. Prior physical theories, resorting to numerical relationships, beats, fusion, and genetics, all are lacking because of incorrect interpretations of physiology or failure to consider mistuned consonances.

Musicians may merely use consonance and dissonance as additional labels, e.g., "It's a major sixth, so it's consonant;" "It's a minor second, so it's dissonant." Psychoacoustical researchers may prefer nonmusicians as subjects because of musicians' labelling tendencies. Van de Geer, Levelt, and Plomp (1962) found that nonmusicians evaluated (rather than named) intervals on dimensions of consonance-dissonance, euphonious-diseuphonious, and beautiful-ugly. Plomp and Levelt (1965) used nonmusical subjects in producing evidence that consonance-dissonance may be a matter of how partials from the tones comprising a simultaneous interval align along the basilar membrane: Basilar membrane stimulations that are identical *or* are separated by a critical band width promote consonance; nonidentical stimulations *within* a critical band width promote dissonance. More recently, Pierce (1999) suggests that the consonance of simultaneous intervals depends on the degree of separation of the individual tones' partials. In a classic study of *categorical perception,* the phenomenon where differing stimulus objects are categorized identically as long as they remain within certain bounds, Siegel and Siegel (1977) found musicians tending to categorize intervals very accurately but to make few distinctions in interval size within interval categories: Although 77 percent of the intervals were out-of-tune, the six musicians judged only 37 percent as such.

The diversity of meanings and contextual qualifications may suggest relegating consonance-dissonance to a list of designated arcana, something for researchers to examine when they are bored. Farnsworth (1969, p. 44) long ago said, "Musical science [sic] would be the better were this concept [consonance] dropped from the scholarly literature." Farnsworth's recommenda-

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[8]Centuries ago, thirds and sixths were considered dissonant. Even today, some people refer to those intervals as "imperfect" consonances; the other consonant intervals are "perfect" consonances.

tion is extreme, given the persistent, albeit inconsistent use of the terms. Less radically, Bharucha (1984) relates consonance-dissonance to musical context by suggesting that establishment of tonality at the beginning of a musical work generates expectancies regarding stable and unstable tones in a melodic context. Unstable tones tend to resolve or be assimilated into stable tones or anchors; consonance or dissonance then may have meaning in accordance with melodic structure. This may be far more salient than labelling or evaluating isolated intervals.

Sethares (1998) suggests that rather than being interval phenomena, consonance and dissonance depend on the tonal spectrum. Since timbre (the apparent quality of a sound, discussed below) varies with the mix of frequencies and their relative amplitudes and phases which comprise a spectrum, consonance and dissonance result from timbre. Sethares describes a dissonance curve, the height of which depends on the frequency relationship and the relative amplitudes of the interval components. Intervals occur within a scale context, and spectra and scales are related if the heights of the dissonance curves are at minimal positions for scale degrees in relation to a tonic. Just what is dissonant will vary with the spectrum; the classically dissonant augmented fourth is not dissonant with certain spectra. The details of the Sethares approach are complex; readers are referred to his text for details of his functional dissonance curve equations. The main point is that yet again, consonance-dissonance are perhaps better conceived as musical contextual phenomena rather than isolated intervalic phenomena. Regardless of conception or labelling, the phenomena will not go away; they are inextricably bound up with the auditory system's processing of multiple sounds (Pierce, 1999).

APPARENT PITCH. An interval comprises two tones. Normally, each tone retains an individual pitch identity within the simultaneous interval; the interval is not a unitary sound (unless it is a unison). Yet, a certain amount of tonal *fusion* may occur; fusion may suggest an intervalic pitch.

Farnsworth (1938, 1969) investigated Stumpf's principle, which said that the lower tone dominates the pitch of any simultaneous interval. Contrarily, Farnsworth found that the upper tone dominates, except for musically untrained individuals and some basses. Since harmony, an extension of intervals, is not a unitary pitch sensation, the whole concept of a single pitch for an interval seems amorphous, although there may be some value in studying dominance of one part of a harmonic section over another.

One still unanswered question is why two simultaneously sounding sources, like two violin strings, usually produce what people hear as an interval, but a single sound source, such as a complex tone or even a noise that is more complicated acoustically than the interval, is heard as one sound. The answer may lie in the brain's ability to use various cues related to localiza-

tion and transient waveform characteristics (Roederer, 1995, pp. 58–62). Deutsch (1982, p. 108) notes that Helmholtz, a pioneering psychoacoustician, suggested in 1885 that a complex tone sounds as one tone because all of the components start and stop together.[9]

APPARENT SIZE. Musical intervals usually are specified by their upper tones' scale degrees (third, fourth, sixth, etc.) in relation to their lower tones, subject to modification by accidentals (minor, major, augmented, diminished). Another way is to specify the interval ratio; each interval in its simplest (just) form has a characteristic frequency relationship between the upper and lower tone. Any perfect octave's upper frequency is related to its lower frequency as 2 is to 1. Any perfect fifth's upper frequency is in a 3:2 ratio with its lower frequency. Other characteristic ratios are 16:15 for a minor second, 9:8 for a major second, 6:5 for a minor third, 5:4 for a major third, 4:3 for a perfect fourth, 7:5 for an augmented fourth, 5:3 for a minor sixth, 8:5 for a major sixth, 9:5 for a minor seventh, and 15:8 for a major seventh. In performance practice, considerable deviation from the simple ratios occurs. In the equally tempered scale, derived by dividing the octave into equally sized semitones (half steps), no interval except the octave has the characteristic ratio. (Due to categorical perception, listeners can recognize and classify intervals that only approximate the "true" ratios.) The most exact way to indicate physical interval size is in cents (one cent = 1/1200 of an octave). The intervalic cents formula is

$$n = 3986.31[\log(f_2/f_1)],$$

where n is the number of cents in the particular interval, f_2 is the frequency of the upper tone, and f_1 is the frequency of the lower tone (Backus, 1977, pp. 349–350).

All identically named intervals share a perceptual similarity, regardless of their particular frequency components, which aids in identification and musical utility. As one can demonstrate with the cents formula, any two intervals sharing the same ratios will be physically identical in cents (e.g., the 2:1 octaves 60 and 30 Hz and 3000 and 1500 Hz are both 1200 cents). However, if a successive interval is evaluated rather than simply categorized, its apparent size may vary with frequency range. Evidence is conflicting: Some research (Stevens, 1975; Stevens, Volkmann, & Newman, 1937) suggests that physically identical intervals increase in apparent size with increasing frequency range; Winckel (1967) says that intervals in lower frequency ranges have greater "melodic distance," which implies that they apparently decrease

[9]Since the individual patterns of vibration (vibration modes) within a complex tone do not necessarily decay (weaken) at the same rate, the components may not stop together, yet the complex tone sensation is unaffected (see Hall, 1991, pp. 171–172).

in apparent size with increasing frequency range. Radocy (1978) found that perceived interval size is a highly idiosyncratic function of interaction among the particular interval, interval direction, subjects' musical experience, and frequency range.

Beating

First order beating, a perceptible rise and fall in loudness, is experienced with the simultaneous sounding of two slightly different frequencies. It results from the periodic changes in the superposed waveform. The beat frequency for a mistuned unison is equivalent to the difference between the two frequencies; the greater the frequency separation, the faster the beating. With sufficient frequency separation, the beating becomes roughness. Once the frequency separation is great enough that the difference between the basilar membrane stimulations equals the critical band width, the listener experiences a clear sensation of two simultaneous tones. Beating provides a very obvious clue that two instruments or voices are "out of tune" with each other. However, tuning by eliminating the beats between a reference tone and a tone to be tuned may be ambiguous (to the tuner) because of uncertainties regarding the direction of deviation. After investigation, Corso (1954) long ago suggested that unison tuning may depend more on pitch matching than on beat elimination.

Beating of a mistuned interval other than a mistuned unison, particularly an octave, fourth, or fifth, is *second order beating* (Roederer, 1995, pp. 40–43), which may result from the peripheral interference of combination tones, or, especially at lower frequencies, from central neural processing (Plomp, 1976). Also known (unfortunately) as the beating of mistuned consonances, second order beating is more ambiguous than first order beating. Just what fluctuates or "beats" is not obvious. Second order beats are strong when the beating interval is below 500 Hz. The beats become progressively weaker above 1000 Hz. When audible, the beats do not disappear when noise is introduced to cover (mask) possible peripheral effects such as combination tones; evidence strongly suggests central processing of second order beats (Plomp, 1967a).

If a different sound is presented to each ear in such a manner that the sounds can not possibly mix until they reach the neural pathways, *binaural beating* may occur. Perrott and Nelson (1969) found that likelihood of such beat detection varied with frequency, with detection most likely around 500 Hz. The beats may appear as a rapid flutter, or, especially with small frequency differences, a fused sensation may appear to travel around inside the listener's head. While binaural beats may appear to have relatively little musical significance, the expanding technology encompassing ever more

sophisticated headsets and virtual realities may enable composers, arrangers, and various entrepreneurs to exploit binaural effects.

First and second order beating are musically significant. Piano tuners may count beats to obtain the tempered tuning of designated intervals. Instrumentalists may be confident that they are in tune once first order beats disappear. One reason that one French horn amplified to 10 times its output does not sound like ten horns is that complex beating among ten horns' outputs adds a "richness" to which listeners are accustomed: This is the *chorus effect* (Backus, 1977, pp. 121–122).

Absolute Pitch

Absolute pitch, the ability to name a tone without reference to any external standard, may astound people who do not possess it. People with absolute pitch may view their "gift" as quite ordinary and an occasional nuisance. Relative pitch, the ability to name a tone in relation to an external standard, is quite common among musicians; to label a C as "C" because it sounds a perfect fourth lower than a known F only requires knowing intervalic relationships. Naming the C when only C is heard with no reference is qualitatively different and much less common.

Investigators have suggested that absolute pitch results from sensitivity to tonal chroma[10] (Bachem, 1954), that it results from deliberate learning (Corso, 1957; Meyer, 1956), and that it could result from learning and internalizing a reference tone (Cuddy, 1968). Cuddy noted that judgments of piano tones were related specifically to piano experience. Internalizing a particular reference seemingly would enable one to display absolute pitch, but differing degrees of accuracy with different performance media suggest that one may learn a "pseudoabsolute" pitch by using auditory cues other than frequency, e.g., timbre characteristics.

The concept of a critical age period, when a child is especially ready to develop particular skills, suggests that a "window of opportunity" exists for a few years. Although Bruer (1999) recently questioned the concept, particularly as a "now or never" time for very young children, one prominent view of absolute pitch development relates learning tonal identification to a critical period, roughly ages four to seven years, when pitches of individual sounds have a greater salience, in both music and speech, than they do in later life. Sergeant (1969) showed that a majority of surveyed adults possessing absolute pitch experienced musical training during the critical age

[10]Tonal chroma are cyclical characteristics that are consistent across octaves. All tones with a given letter name share a common characteristic; i.e., all A's have a certain "A-ishness," all B's have a certain "B-ishness," etc.

period.[11] De Gainza (1970) indicated that isolated sounds attracted her small children, but as they matured musical form, structure, and tonal relations became more salient than individual pitches. The auditory system can perceive details, but it also can perceive structure: In music, structure becomes more important than the details which foster absolute pitch development. Indeed, in a musical context, pitch relationships usually are more important than the actual pitches themselves. The critical period involves an *imprinting* theory, analogous to the maternal connection a hatched duckling makes with the first moving object it encounters (usually mama duck). During the critical period, a label is highly associable with a tonal sensation, and the correct label-sensation associations, if formed, become absolute pitch.

Investigation of absolute pitch requires using varied stimuli and avoiding relative pitch cues. Ability to label tones only from an instrument with which the listener is familiar or coming within a minor second of the correct letter name are not enough to justify labelling the listener as possessing absolute pitch. Many people probably can learn to identify certain tones some of the time, but few can learn to identify all tones all of the time. In their detailed discussion of absolute pitch, Ward and Burns (1982) indicate that frequency-pitch relationships are acquired early in life and that, despite many attempts, only one person has been able to acquire absolute pitch as an adult. In a later edition of the text in which the Ward and Burns chapter appeared, the updated article (Ward, 1999) indicates that attempts to teach absolute pitch generally are unsuccessful, and that possessors' internal standards may shift after age 50. If absolute pitch is desirable, more consideration of the means by which the *labels* are attached to the sensations, particularly in the alleged critical period, is necessary.

Pitch Measurement

Pitch may be measured in various ways, but any technique must use a human observer (or an apparatus built to simulate one). The stroboscope, digital frequency counter, and spectrum analyzer measure frequency, not pitch. Since pitch is defined as a human sensation, its measurement requires human sensation.

Qualitative judgments in the form of pitch matching, as illustrated by intonation judgments and tuning adjustments, are one type of pitch measure. Quantitative judgments are illustrated by the *mel* scale, where 1000 mels equals the pitch sensation of 1000 Hz (Stevens, Volkmann, & Newman, 1937). A table equating frequency in Hz to pitch in mels appears in Stevens

[11]Although he has heard tales of individuals not acquiring absolute pitch until adulthood, in 29 years of university teaching, each person that one of the authors (RER) met who possessed absolute pitch had begun piano study no later than age seven.

(1975, pp. 310–311). The pitch sensation "twice as high" as 1000 mels (2000 mels) requires a frequency of 3120 Hz, not 2000 Hz. The mel scale generally predicts psychological interval sizes that are larger than physical sizes and larger than the judgments of many listeners, including musicians and nonmusicians (Radocy, 1977). Indeed, the psychological octave often is larger than the physical octave, possibly because auditory neurons' firing time intervals exceed the time required for one octave's vibration cycles (McKinney & Delgutte, 1999).

While musicians generally consider the mel scale an impractical curiosity (if they are aware of it) because its predictions of apparent interval size are inaccurate, and the mel scale was developed with pure tones, Shepard (1999, pp. 152–153) insists that the mel scale nevertheless says something important about pitch: It relates to the statistically higher number of close intervals found in the central frequency range in musical works, and may relate to a tonal property of brightness. Indeed, one is more likely to find intervals smaller than a fourth in the middle of the musically useful frequency range.

Loudness Phenomena

Not all audible sounds have pitch–some sounds are just too complex for the fundamental tracking mechanism to assign a definite pitch. Loudness, however, is an obvious property of all sound–if a sound is audible, it must have loudness. Listeners, even very unsophisticated ones, readily may evaluate musical performances as "too loud" or "too soft." Music educators direct considerable pedagogical effort toward improving students' sensitivity or musicality by urging them to use more effective dynamic contrasts in performance.

Whereas pitch is a metathetic and a morphophoric variable, loudness is a prothetic variable, a variable of apparent size or magnitude. Shepard (1999, p. 25) notes that loudness relationships have a certain auditory constancy, analogous to the visual constancy experienced in viewing a tree against a background of further trees–as one approaches the foreground tree, everything appears larger, but the relative sizes of the foreground and background trees remains the same. In a musical setting, although limitations exist, one theoretically is able to increase or lower the overall dynamic level of a performance while maintaining the dynamic contrasts within the piece. Pitch constancy is in relationships of apparent location; loudness constancy is in relationships of apparent strength.

The differences between pitch and loudness apparently affect musical usage and priorities. Although human ears are sensitive to about a trillionfold range of sound intensity and to only about a thousandfold range of frequency, minute loudness distinctions lack the musical importance of minute

pitch distinctions. Loudness notation is limited to symbols for dynamic levels and words indicating a gradual change, whereas pitch notation has specific locations on a musical staff. Furthermore, although six basic dynamic levels—*pp*, *p*, *mp*, *mf*, *f*, and *ff*—have been used for over 200 years, few instrumentalists have a dynamic range capable of attaining those six discrete levels. This generally is not due to limitations of performance media. Restricted musical dynamic ranges and solo passages equal in loudness to full orchestral passages, characteristic of films and television, as well as popular music with basically two dynamic levels, loud and even louder, may be partly responsible, but the general artistic demand for a wide range and variation in loudness seems restricted (Patterson, 1974).

Our loudness discussion is organized around distinguishing loudness from other properties, measurement of loudness and systematic relations therefrom, masking, loudness summation, and dangers to hearing.

Intensity-Loudness Relationship

Intensity and loudness are not interchangeable terms. *Intensity* is an objectively measured physical property, an amount of power. It often is expressed in power units per unit area, as in watts per square meter (w/m^2). *Loudness* is a subjective sensation of a sound's magnitude or strength. Its perception requires an animate perceiver (or a machine built to simulate one). Sound level meters and spectrum analyzers do not measure loudness.

The amount of a sound's intensity is the major determinant of its loudness, but the intensity-loudness relationship is not simple. A minimal perception time, varying from 10 to 500 msec and beyond, is necessary for a sound to build to its maximal perceived loudness (Scharf, 1978, pp. 205–206), and loudness may vary further with the time required for a sound to reach its maximum intensity (Gjaevenes & Rimstad, 1972). Prolonged steady sounds may diminish in loudness due to auditory fatigue, where the brain essentially diminishes attention to a prolonged sound because of irrelevance, or to habituation, a reduction in stimulated neural activity (Roederer, 1995, p. 96). Frequency confounds the intensity-loudness relationship; as discussed below, the loudness a particular intensity elicits varies with frequency. The ear's variation in sensitivity with frequency is especially important for music; in general, lower sounds may be played "louder" than higher sounds before they are judged as being too loud.

Volume, Density, Annoyance, and Noisiness

Other sound properties tangentially related to loudness include volume, density, annoyance, and noisiness. *Volume* is the apparent size or extensity of a sound, illustrated, for example, by a tuba usually sounding "larger" than a piccolo. However, the piccolo usually sounds more focused or pinpointed than the tuba; a sound's apparent compactness or focus is *density*. The esteemed psychophysicist S. S. Stevens (1934a, 1934b, 1975) believed that both were basic tonal attributes, varying as functions of frequency and intensity combinations. Today, volume and density basically are psychoacoustic curiosities with little musical relevance.[12]

Hellman (1982, 1985) studied subjects' judgments of tones embedded in background noise and identified properties of *annoyance*, the apparent irritation of a sound, and *noisiness*, the clarity of a sound. Again, these are not important basic tonal properties, but they suggest that people who complain about excessively loud music may be reacting to something other than excessive sound strength.

Measurement of Loudness

Quantifying loudness is challenging, controversial, and, for some, impossible. Quantifying the physical stimulus is relatively easy, but quantifying the sensation the stimulus elicits is not. Various approaches exist.

STIMULUS MEASURES. For some people, measuring the stimulus may be sufficient, even though that is not measuring loudness. Intensity is defined as an amount of power per unit area, and watts per square meter (w/m^2) are common units for sound intensity. Most sound intensities are rather small values. Just one w/m^2 is a rather intense sound that approaches the upper limit of hearing, sometimes called the threshold of pain. At 1000 Hz the threshold of hearing is around .000000000001 w/m^2, one-trillionth of a watt. Writers often use negative powers of ten to express such tiny decimal fractions; the above threshold of hearing is 10^{-12} w/m^2.

Sound intensity usually is expressed in terms of intensity *level* rather than pure intensity. Intensity level represents a comparison with a baseline value, just as a building's fourth floor is the fourth floor in comparison to the ground. Comparisons of particular intensities to baseline values are ratio comparisons using *decibels*.

Decibels, often abbreviated as dB, are measures of power ratios. They are not limited to sound: Ratios of light and electric current also may be expressed in decibels. Decibels are best defined by the computing formula. For sound intensity level,

$$D_{IL} = 10[\log(I/I_0)],$$

Where D_{IL} is the number of decibels, I is the particular intensity bein[g]

[12]The authors continue to recommend not using "volume" as a synonym for loudness, albeit wit[h] little success!

compared to a baseline and placed on the particular intensity level, and I_0 is the baseline value. The intensity at the threshold of hearing is often used; hence 10^{-12} w/m² is a common baseline.[13]

Three consequences of a decibel value being a shorthand expression of a ratio are that (a) 0 dB does not mean an absence of power or a sound, (b) a relatively small range of decibels expresses a relatively large range of acoustical power, and (c) one can not simply add decibel values to obtain an intensity level for sound combinations.

A comparison of a baseline with itself will yield an intensity level of 0 dB. This is not necessarily inaudible, depending on frequency; it simply is the result of the 1:1 ratio formed by identical intensity values. It is not a true zero, the genuine absence of the property in question.

An intensity level of 60 dB represents the comparison of an intensity of 10^{-6} w/m² (.000001 w/m²) with a baseline of 10^{-12} w/m². Similarly, 70 dB represents 10^{-5} w/m² (.00001 w/m²). The 10 dB difference represents a tenfold (10:1) difference in power–.00001 is ten times .000001. An intensity level of 80 dB represents .0001 w/m² (10^{-4}); the difference between 80 and 60 dB represents a one hundredfold (100:1) difference in power–.0001 is 100 times .000001. *Any* 10 dB difference in intensity level means that one sound has ten times the intensity of another. A 20 dB difference always represents one sound having 100 times the intensity of the other; a 30 dB difference represents 1000 times, 40 dB 10,000 times, etc. The decibel scale is logarithmic; equal decibel amounts represent equal ratios.

Given what the individual values represent, two decibel values can not be summed directly in any meaningful way. Two intensity levels of 60 dB do not total 120 dB–they total approximately 63 dB. Each intensity corresponding to 60 dB is .000001 w/m²; .000001 w/m² + .000001 w/m² is .000002 w/m², not .00001 w/m², represented by 70 dB, and *certainly not* 1.0 w/m², which is represented by 120 dB. *Any* intensity level increases by approximately 3 dB when combined with an equivalent level. (Even 0 dB + 0 dB = 3 dB.) If two summed values are not equivalent, the result will be something less than 3 dB added to the higher level; e.g., 60 dB + 59 dB = 62.2 dB.[14]

Although sound intensity level has become easier to measure in recent years, *sound pressure level* (SPL) remains a more common stimulus measure. SPL usually is easier to measure, and it relates logically to the concept of pressure variations relating to sound sensations. SPL decibels are computed differently, in relation to a different baseline, although the ratio comparison principle is the same. A common formula is

$$D_{SPL} = 20[\log(P/P_0)],$$

where D_{SPL} is the number of decibels, P is the particular pressure value of concern, and P_0 is the baseline pressure. A common baseline is .00002 newtons per square meter (n/m²). With SPL decibels, a difference of 20 dB represents a tenfold difference; 40 dB represents a hundredfold difference, etc. Most dB values found in research reports are SPL values. Ideally, investigators would express dB values that clearly specify the baseline and the property.[15] Often they do not, so the reader generally assumes SPL, with a .00002 n/m² baseline.

Sound level meters can describe the sound pressure level at a particular location quite adequately. More sophisticated integrating sound level meters can provide other values of interest, values which are extensions of basic SPL readings. The equivalent continuous sound level (L_{eq}) is the same amount of energy content as a varying SPL over a designated time period; e.g., one hour of 100 dB SPL plus seven hours of 70 dB SPL yields an L_{eq} for the eight hours of 91 dB. The day-night level (L_{dn}) is also SPL spread over a period of time, except that readings from part of the time, often night time hours when many people wish to sleep, are biased upwards by 10 dB. Sound exposure level (SEL) is the constant SPL of a one second sound which has the same amount of acoustic energy as the original sound; essentially, a sound spread over a longer time period is squeezed into one second. The SPL which is exceeded a certain criterion percentage of the time may be recorded; e.g., L_{10} = 90 dB SPL would mean that 10 percent of the time during a designated period the SPL equalled or exceeded 90 dB. In all cases, these are physical measures. While one may infer psychological consequences, they are not response measures.

RESPONSE MEASURES. A conservative view of loudness measurement says that one can describe loudness but not measure it. A more liberal view says that one can make equivalency judgments, but scaling loudness is impossible: We can say that a sound is as loud as, louder than, or softer than another sound, but we can not say it differs by any particular amount. A more rad-

[13]Other baselines exist. Dirks, Ahlstrom, & Morgan (2000, p. 197) say 10^{-16} w/m² (.0000000000000001 w/m²) is most common.

[14]This assumes that the two underlying vibrations are in phase. If phase relationships change, the height of the superposed waveform changes, so the intensity level changes. Constantly alternating constructive and destructive interference, as in first order beating, will result in a constantly changing combined intensity level. Destructive interference may result in a combined intensity level which is less than that of any single component; totally destructive interference will result in no intensity (which is not 0 dB).

[15]Intensity level and sound pressure level decibels are related mathematically because the intensity ratio I/I_0 is equivalent to the square of the pressure amplitude ratio ($A_1/_2$). Symbolically, dB = 10 [log (I/I_0)] = 10 [log $(A_1/A_2)^2$] = 20 [log (A_1/A_2)]. See Dirks, Ahlstrom, and Morgan (2000, p. 198).

ical view is that loudness can be scaled, as long as one does not require counting units.

Equal loudness curves, a sample of which appears in Figure 4-4, connect frequency-intensity combinations, usually for pure tones, which judges deem to be equivalent in loudness. Any two points on an equal loudness curve are equally loud, at least as averaged across a set of judges. The general shape is such that the curves "go down" as auditory sensitivity increases with frequency to around 2000 Hz; beyond about 3000 Hz, sensitivity decreases and the curves "go up." Even without measurement aspects, the curves are important because they show clearly that the ear is not equally sensitive at all frequencies in the hearing range: The curves indeed are *curved* because frequency confounds the intensity-loudness relationship. Without such confounding, i.e., if a particular intensity elicited a constant loudness across all frequencies, the "curves" would be straight lines. Fletcher and Munson (1933) made some of the first equal loudness curves by having eleven judges make 297 observations of comparative loudnesses; in their honor, equal loudness contours often are called "Fletcher-Munson curves."

The curves are not exact; in addition to interpolation of data points, the curves are influenced by the standard frequency to which judgments are related (Molino, 1973) and whether one listens in a free field or through headphones (Scharf, 1978). Controversy continues regarding the accuracy of the curves and biases inherent within them (Plack & Carlyon, 1995).

Any two theoretically equal points on an equal loudness curve are equal in *phon* value. Phons are equivalent to decibels at 1000 Hz; e.g., a 1000 Hz tone of 60 dB is also 60 phons: Any other frequency-intensity combination judged as equal to the 1000 Hz-60 dB combination also is 60 phons. Phons technically are measures of loudness *level*, not loudness. They enable loudness comparisons at the equal to, more than, or less than level. Just as with decibels of intensity or sound pressure level, one can not add or subtract phon values in any meaningful way.

Of various attempts to develop a measurement scale on the basis of how much louder one sound is than another (Beck & Shaw, 1967; Stevens, 1975; Warren, 1970), the *sone* scale probably is best known. Originally, one sone was equal to 40 phons. A later definition (Stevens, 1972, 1975) is that one sone is the loudness of a third-of-an-octave band (frequency spread) of noise, centered on 3150 Hz, at an SPL of 32 dB. Sones are based on human subjects' judgments of sensation ratios. On paper, they have a systematic relationship to decibels; a growth in SPL of 9 dB elicits a doubling of sone value. (Stevens [1975, pp. 312–317] presents a table of sone-decibel relationships.) The sone scale may not be entirely satisfactory, and researchers are free to develop other loudness scales. Such a scale necessarily is subjective because loudness, however measured, is a subjective psychological property. Any

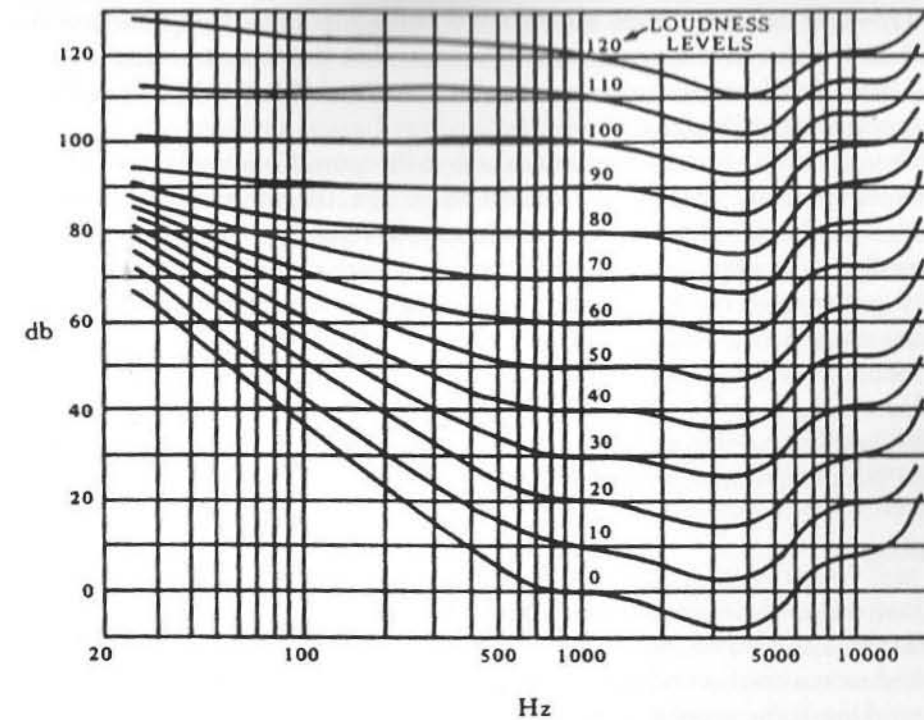

Figure 4-4. Sample equal loudness curves. The curves connect frequency-intensity level combinations which are judged to be equally loud as a 1000 Hz standard of a given intensity level.

measure of sound which is not based on judgment can not measure a psychological sensation resulting from sound.

The Power Law

The power law essentially says that a lawful relationship exists between an increasing physical stimulus value and the rate of growth in some associated psychological response. That relationship is expressed by a decimal exponent, a "power function," expressing the size of a response ratio as a function of a stimulus ratio. Equal stimulus ratios elicit equal sensation ratios. Under many conditions, the law seems to hold. Stevens' (1975) text, published posthumously with his widow's assistance, provides many details. Magnitude estimation, a highly useful measurement technique that is based on matching one stimulus dimension to another rather than counting units, is important in obtaining the response measures necessary for investigating power law relationships. Stevens describes magnitude estimation in theory and in psychophysical applications; Boyle and Radocy (1987, pp. 185–189) describe it in the context of musical performance evaluation. Plack and Carlyon (1995,

pp. 128–129) call magnitude estimation a "straightforward" approach to the necessarily subjective assessment of loudness, but they caution that instructions, size of differences between stimulus sounds, and individual biases may influence listeners' judgments.

When loudness is measured in sones and the stimulus is a narrow band of noise centered on 3150 Hz and measured in SPL dB, the theoretical power function is .67. In actual practice, other power functions may occur. The power function will vary with the stimulus frequency range. Loudness generally grows more rapidly at lower frequencies, and individuals vary in their sensations and their abilities to match their sensations with numbers. Despite the inconsistencies in power law relationships, one should recognize that (a) loudness may grow systematically as a function of natural perceptual processes, and (b) individuals are capable of making more subtle loudness judgments than traditional musical dynamic markings suggest.

Masking

Obviously, one sound, normally perfectly audible by itself, may become inaudible in the presence of a louder sound; this is *simultaneous masking*. The masked or covered sound is the masked tone (or noise); the sound that does the masking is the masker. Orchestral woodwind players sometimes will disregard certain technically demanding passages because they are not "exposed." They feel that since other instruments will mask the "unexposed" passages in full orchestral performance, there is no need to give special attention to the passages in practice sessions.

Classical studies of simultaneous masking generally show that a masker's most effective masking is for sounds near its frequency[16] (although some evidence suggests that the masker may be more distant from the masked sound (Espinoza-Varas & Watson, 1989, p. 89)), that the frequency area over which masking may occur may be greater for frequencies above the masking frequency (especially at high intensity levels), and that a noise is a more effective masker than a tone (Egan & Hake, 1950). In comparing a 45-partial inharmonic stimulus with a 45-harmonic stimulus, each based on a fundamental frequency of 88 Hz, Treurniet and Boucher (2001) found that the inharmonic stimulus was a more effective masker than the harmonic stimulus, but not as effective as a noise with an 800-Hz bandwidth. Oh and Lufti (2000) also found that inharmonicity enhanced the effectiveness of a masking sound. Simultaneous masking has obvious musical importance. It also is exploited in environmental situations, as in providing background music or noise to mask undesirable sounds.

Simultaneous masking is common in everyday life. Forward and backward masking are possible in laboratory situations. In forward and backward masking, the masking sound respectively precedes or follows the masked sound by a very brief time period. Forward masking probably is a matter of reduced auditory sensitivity or prolonged neural stimulation from the masker. Backward masking[17] is mysterious; it may result from listeners' confusion of the weaker masked signal with the following stronger masking signal (Moore, 1989, pp. 119–122).

Loudness Summation

Individual loudnesses sum to form combined loudness, but the summation is not a simple process of addition. Since sounds summate differently under different conditions, loudness summation has importance for musical performance, composition, and arranging.

Using an early tone synthesizer, Fletcher (1946) demonstrated that the mixtures of frequencies contained in complex tones sounded louder than the single frequencies of pure tones. Stevens (1956) noted that separate noise bands (and, by analogy, groups of frequencies) are not simply additive. Even widely separated frequencies can have a mutually inhibitive effect.

In an oft-cited study, Zwicker, Flottorp, and Stevens (1957) showed that loudness summation for pure tones depends on frequency separation in relation to the critical band width. When the frequency spacing (Δf) between simultaneous tones increases to a critical point (Δf approximately equal to 100 Hz for a 500 Hz standard, to 180 Hz for a 1000 Hz standard, to 350 Hz for a 2000 Hz standard), the loudness sensation increases. A similar loudness increase was noted when the width of a noise band was increased beyond a certain point. At low SPLs, with wide frequency spacing, no summation occurs; the total loudness is equivalent to the loudest individual tone. Loudness summation appears greatest for tones at a loudness level of 50 to 60 phons; uniform spacing of frequency components produces greater loudness than nonuniform spacing.

One may relate the three "cases" of loudness summation identified by Zwicker et al. to the critical band width (Roederer, 1995, pp. 92–93). Frequency components *within* a critical band width summate so that the total loudness is the loudness elicited by the sum of the original intensities. Components *beyond* a critical band width (but not greatly so) summate so that the total loudness is the sum of the individual loudnesses elicited by each

[16] If both the masker and the masked sound are tones, first order beating may indicate the presence of the softer masked tone when the masked tone's frequency is close to that of the masking tone. Second order beating may reveal octave relationships.

[17] In this context, backward masking refers to inability to hear a sound that occurred earlier in time. It is not the use of "backward masking" or "backmasking" to refer to incomprehensible or inaudible messages becoming clear when a tape is played backwards.

intensity. Symbolically, using L_T to indicate total loudness, Σ to indicate summation, I_1 through I_n to indicate a group of individual intensities, and E to indicate an "eliciting operator" for converting an intensity or group of intensities to the elicited loudness, the first case (within the cbw) is

$$L_T = E[\Sigma(I_1 + I_2 + \ldots + I_n)].$$

The second case (beyond the cbw but not greatly so) is

$$L_T = \Sigma[E(I_1) + E(I_2) + \ldots + E(I_n)].$$

The third case, where the components are well beyond the cbw, is where the total loudness is equivalent to the loudest component; there is no summation.[18]

In writing and arranging music, composers and orchestrators may exploit the different cases of loudness summation. A fully scored "open spacing" chord usually sounds louder than a "close spacing" chord, even with an identical number of instruments. In addition to differing in timbre, octaves usually sound louder than unisons. Generally, unless the frequencies differ extensively, two well-spaced frequencies will sound louder than two frequencies quite near each other.

The critical frequency difference for loudness vanishes under conditions of dichotic presentation. For ear differences between the separate frequencies of 0 to "several thousand" Hz, Scharf (1969) noted that dichotic pairs remain equally loud. Dichotic summation occurred even when the tonal sensation was of two separate localized tones, one in each ear. This is logical, given studies relating ordinary loudness summation to the basilar membrane's critical band width. Dichotic presentation prevents phenomena that depend on the cbw.

In one of his last published works, Stevens (1972) outlined a computational procedure, based on laboratory observations, for the perceived loudness of a noise divided into third-octave bands. By analogy, it may apply to mixtures of complex tones. The procedure uses a standard reference of a one-third-octave band of noise centered on 3150 Hz, the sone as defined earlier, the power law for loudness, equal loudness contours for noise, and the summation rule

$$S_t = S_m + F(\Sigma S - S_m),$$

[18] This all assumes unchanging relative phase. In reality, as phase changes, the total amplitude of the superposed waveform, its combined intensity, and the resulting loudness will change as interference patterns change. Again, a combined (summated) loudness may be softer than any of its components, especially with two components in case one.

where S_t is the total loudness, S_m is the loudness of the loudest sound, ΣS is the sum (in sones) of the loudness of all bands, and F is a tabled value which varies as a function of the loudest band.

Zwicker and Fastl (1990, pp. 213–214) proposed measuring loudness via a "loudness meter" which could measure specific loudnesses among the various critical bands encompassing the hearing range. Basically, the "meter" would be calibrated in third-octave frequency bands, with adjustments for low (< 280 Hz) frequencies. It would make readily apparent those parts of a complex sound that contribute most to overall loudness.

A listener often experiences music in a confined space, which may interact with the musical stimulus to add further complexity to loudness summation, and the basic loudness sensation itself. The physical sound level varies with different locations, yet the loudness sensation may vary less. Harrison and Thompson-Allen (2000) demonstrated that the impression of loudness constancy of pipe organ sounds at different points in a church was greater than the variability of SPL readings around the church would suggest. The constancy effect was greater for reed than for diapason sounds. Indeed, a basically simple sensation can become quite complex.

Dangers to Hearing

Exposure to excessively loud sounds endangers hearing. Extensive documentation from over a 30-year period leaves no question that loud sounds, regardless of their source, may induce sensorineural deafness. According to Shulman, Lambert, and Goodhill (2000, p. 773), about one-third of hearing-impaired Americans have a hearing loss attributable to noise exposure—exposure that almost always could have been prevented. Ear damage may be in the form of acute acoustical trauma or noise-induced hearing loss (NIHL); the outer hair cells are especially vulnerable, although damage can progress to the inner cells. Acute acoustical trauma occurs with exposure to sounds above 120 to 130 dB SPL; even brief exposure is dangerous at such high levels. NIHL comes from more long-term exposure to sounds above 90 dB SPL (Brookhouser, 2000; Shulman, Lambert, & Goodhill, 2000).

For a while, listeners may encounter loud sounds and experience only *temporary threshold shift* (TTS), a short-term impairment: Temporarily, a greater amount of intensity is necessary in order for the listener to just perceive a sound. Temporary threshold shifts may depend on the amount of SPL in the critical bands around the affected frequencies as well as the exposure time (Yamamoto, Takagi, Shoji, & Yoneada, 1970). With prolonged exposure, as in working regularly in a noisy environment or listening to music at high loudness levels night after night, the threshold shifts very well may become permanent.

Given the loud percussive style of much rock music, investigators have studied hearing decrements in rock performers and listeners. Jerger and Jerger (1970) measured the hearing sensitivity of nine rock performers just before a performance and within one hour of the performance's conclusion. Eight musicians showed a threshold shift of at least 15 dB for at least one frequency in the 200–8000 Hz range;[10] some losses were as high as 50 dB. Rintelmann, Lindberg, and Smitley (1972) exposed 20 women with normal hearing to recorded rock music at 100 dB SPL under two conditions: one as 60 minutes of continuous music, the other as three-minute music segments alternating with one-minute segments of "background" (80 dB) disco noise. The TTS was less for the intermittent music condition, although recovery (return to normal hearing threshold) was about the same for both conditions. The investigators noted that 50 percent of the women in the intermittent condition and 80 percent in the continuous music condition were "endangered" in accordance with published standards restricting daily exposure to high sound levels.

People's willingness to expose themselves to music at high sound levels despite dangers to hearing exemplifies risking future harm in the interest of immediate pleasure, as in smoking, excessive eating or drinking, and various forms of addiction. Yet, in the case of pulsating, incessantly pounding rock music (wack-a-ZOOM, wack-a-ZOOM, wack-a-ZOOM . . .), there may be something more operating. Dibble (1995) identified a "rock and roll threshold," a point at which the music is loud enough to obtain vestibular responses in addition to strictly auditory responses. The inner ear includes the semicircular canals, the organ that maintains balance and a sensation of location in space by responding to movement. The vestibule known as the *osseous labyrinth* communicates motions to the semicircular canals, and the labyrinth responds to high sound levels. Dibble found from electromyographic recordings that a sound in the 100–300 Hz range at a 90 dB SPL or higher could evoke a vestibular response. Five of ten subjects responded at 105 dB; nine responded at 120 dB. The resulting sense of self-motion may enhance the enjoyment of loud sounds. Todd and Cody (2000) also demonstrated that vestibular responses could result from the high sound levels found at rock concerts and in dance clubs, and noted that such a response is possible even in subjects who had lost cochlear function but maintained vestibular function. In more graphic terms, even when the ears surrender acoustically to the incessant pounding, the joy of movement keeps the person in the presence of overwhelming sound!

Personal headsets provide listeners with ample opportunity to hear radio, tapes, or compact discs at excessively high SPLs. The desired musical sounds may mask undesirable external sounds, but the headsets really do not protect their wearers against damage from strong external sounds (Skrainar, Royster, Berger, & Pearson, 1985), and the desired sounds may impair hearing. According to Brookhouser (2000, p. 508), the sound level may exceed 100 dB SPL(A) at the ear, and listeners may compensate for TTS by making the sound even stronger, thereby increasing their risk. As part of their education, children should be alerted to the need to listen safely, along with all of the other safety concerns which are necessary in children's growth and development.

Music educators are obligated to teach students to listen in responsible and safe ways. Unfortunately, music educators themselves may be at risk due to prolonged exposure to strong sounds in rehearsal and performance. Cutietta, Klich, Royse, and Rainbolt (1994) compared the audiograms of 104 music teachers, obtained at least three and one-half hours after any musical activity, with typical patterns of NIHL and presbycusis. Fourteen percent of the subjects showed some degree of hearing loss; this percentage was high in comparison with a population of similar age and gender (Willott, 1991). Nineteen percent showed a typical NIHL pattern. Within the subjects with a type of hearing loss, band directors showed the most adverse effects; their natural age-related declines in hearing sensitivity (presbycusis) evidently were confounded by NIHL. Earlier, Cutietta, Millin, and Royse (1989) found that about 41 percent of a sample of band directors showed some NIHL, as compared with an average of seven percent in the general population of the United States.

Musicians who rehearse large groups in small rooms, stand near powerful speakers while they perform, or feel that they must be "totally bathed" in sound should acknowledge the risks they create for themselves and for others. Investment in a modern set of ear plugs, custom fitted and manufactured to attenuate sound without changing the relative relationships among dynamic levels, is wise for many performers and music students.

Not everyone who smokes will develop lung cancer, and not everyone who listens to music at high sound levels will develop permanent hearing loss. However, excessively loud sounds clearly and dramatically increase the risk of hearing impairment, just as cigarette smoke increases the risk of malignancy in the lungs. The danger to hearing due to exposure to loud sounds is clearly documented; it is not simply propaganda from people who dislike particular musical styles or are unduly bothered by noisy environments. Whether the assault on the hair cells is from rock, Rachmaninoff, rockets bursting in air, rifle fire, or rock slides matters not–the danger is there.

[10]Some frequencies in this range may seem too high for musical purposes, but speech intelligibility suffers from a loss of high frequency because consonants then sound blurred.

Timbre Phenomena

Timbre or tone quality is the tonal attribute that distinguishes tones of identical pitch, loudness, and duration. An oboe and a viola can play an A of identical frequency and sound pressure level for an identical time period, but they clearly sound different. Musically, timbre contrasts influence the character of otherwise nearly identical music greatly; consider the contrast between a piano performance of Mussorgsky's *Pictures at an Exhibition* and a performance of Ravel's orchestration of *Pictures,* or between a pipe organ performance of Bach's *Toccata and Fugue in D Minor* and a performance of Stokowski's orchestration or of Leidzen's band arrangement thereof. More subtly, there are quality differences between a jazz saxophone and a "legit" saxophone sound, and among French, German, and American bassoon sounds. As noted above, Sethares (1998) believes that one can manipulate timbre to make music more consonant or dissonant. Timbre is a highly multidimensional perceptual property, and it is difficult to control separate dimensions, so the research base for timbre perception is less extensive than that for pitch or loudness perception. During the last quarter of the twentieth century, researchers employed sophisticated mathematical analyses and digital tonal analysis and synthesis to investigate particular aspects of timbre. Our timbre discussion includes its relationship to waveform, timbre recognition, and measurement.

Waveform-Timbre Relationship

Timbre is a psychological property. Waveform, the pattern of displacements associated with a sound wave, is timbre's closest quasiparallel physical property. A complex waveform depends on the particular component frequencies, the number of components, the relative strengths of the components, and the relative phases among the components (Backus, 1977). A waveform is a dynamic, changing event; component relationships vary with time and overall dynamic level (Butler, 1992). While musical instruments sound differently to a large extent due to differences in waveform, no static representation of waveform accounts sufficiently for resulting timbre sensations.

Even static portrayals of waveforms require recognition of phase relationships. Authorities once believed that the ear is "phase deaf," in accordance with Ohm's acoustical law. Supposedly, sounds containing components identical in frequency and amplitude but different in relative phase would look different in waveform but sound identical in timbre. Research later showed that while phase sensitivity is relatively weak, relative phase has subtle effects on timbre, particularly when changing phase relationships occur within a continuously sounding tone (Patterson, 1973; Plomp & Steeneken, 1969; Raiford & Schubert, 1971; Risset & Wessel, 1982).

Influences within Waveform

Within the dynamic waveform, the *onset* portion and other transient characteristics are especially important for the timbre sensation. The onset, also called the attack, initial frequency smear, rise time, and initial transient, is the opening portion of a tone, where the energy supplied exceeds the energy expended. In tones produced by a continuous excitation of the vibrating source, such as with a bowed string, a blown reed or mouthpiece, or vibrating vocal folds, the onset is followed by a steady state section, where energy supplied and expended are roughly in balance. Tones produced by impulsive excitation of the vibrating source, such as piano, marimba, and plucked string tones, have no steady state. The *offset* or decay, where energy expended exceeds any supplied, concludes a tone. The *envelope,* the overall "shape" of the sound obtained by connecting the extremes of amplitude in the various tonal sections across time, is an important interactive aspect of the overall timbre. Within the envelope, the relative amounts of time spent in onset and offset are important musical expressive devices, particularly regarding staccato-legato contrasts and phrasing. The strange sounds experienced when a tape is played backwards result in part from the intended offset functioning as an onset, and vice versa.

A vibrating system can not attain a reasonably steady vibration instantaneously. The onset contains a certain amount of "noise" in the form of additional inharmonic frequency components that will not be part of the steady state sound. Individual frequency components differ in their "rise times," or times needed to attain their eventual amplitudes. Individual tones differ in their degrees of inharmonicity and the time required to attain a steady state, if one occurs.

Winckel (1967) discusses extensively onset effects from theoretical and experimental standpoints. Onset times vary among different instruments; the trumpet has a rapid onset of about 20 msec; the flute requires about 200 to 300 msec. Furthermore, any tonal attack includes a rapidly decaying initial "smear" of inharmonic and harmonic frequencies (the onset), and the frequency width (range) and time of the "smear" vary with the quality of attack. Staccato attacks have relatively wide "smears" and short onset times. Legato attacks have relatively narrow "smears" and long onset times. Onset behavior inherent in a musical performance medium is modified by performer idiosyncrasies and the acoustical environment. Winckel's classic work clearly shows that attempts to compare "good" and "bad" sounds via an oscilloscope or to imitate orchestral instruments with organs or synthesizers lacking sophisticated control of tonal portions are unlikely to be fruitful: They can

not duplicate onset behavior.

A second contains 1000 msec; even the "long" onset time of 300 msec is less than half a second. Yet, experiments where the initial tonal portion is physically removed, as in removing part of a recording tape, dramatically illustrate the importance of such a brief time for the timbre sensation. Elliott (1975), for example, demonstrated that experienced musicians may have considerable difficulty in identifying common orchestral instruments when their tones' onset portions are missing.

Caution regarding effects of the onset and other transient aspects on timbre recognition is necessary. In a study comparing college students' abilities to match systematically altered digitally sampled instrument sounds with models, Kendall (1986) found that students were significantly more accurate in recognizing timbre in the context of realistic musical phrases than in that of isolated tones. Yet, context alone was not enough–when transient characteristics were replaced in the synthesized stimuli by steady-state sections, contextual cues were not adequate. Nor were they adequate when reasonably steady-state areas were replaced by transients. Kendall concluded that how the entire spectrum varies across time is important in categorization of timbre.

The relative distribution of energy among the partials may vary with the overall sound pressure level. In general, higher partials have proportionately more energy in tones with greater SPLs than they do in weaker tones (Hall, 1991; Risset & Wessel, 1982). This is particularly true for wind instruments. The band director who asks the band to play with exactly the same timbre in loud and soft passages is asking for an impossibility.

In the free-field listening situation characteristic of a concert hall, reverberant sound dominates direct sound for a major part of the audience. The waveform varies from point to point, so even steady-state portions of tones may have different timbres at different locations (Plomp & Steeneken, 1973).

Butler (1992, p. 141) concludes that timbre perception is complex and influenced by the steady-state waveforms, transient characteristics (especially onset), and slower spectral changes over a series of tones.

Tone Source Recognition

The basilar membrane stimulation pattern resulting from a particular complex waveform's characteristics probably is the physiological basis for timbre perception, at least in the static case of a steady-state waveform (Plomp, 1970).

Balzano (1986) questioned the importance of spectral characteristics regarding distribution of energy, number of partials, etc. He felt that time-based variation is responsible for recognition of particular instrumental

sounds, a form of information which maintains relative constancy regardless of the waveform changes due to changes in an instrument's particular fundamental frequency or overall intensity level.

Roederer (1995, p. 152) discusses dynamic ("in context") tone source recognition as a matter of timbre perception, resulting from neural processing of waveform information, storage in memory with a learned label, and comparison with prior information. Anyone with normal hearing may experience the sensation of a clarinet sound as opposed to a trumpet sound, but distinguishing between the two in terms of labels requires learning, which likely results in neural modification of cortical structures.

Measurement of Timbre

Timbre is multidimensional. As a result, there is not and can not be a measurement unit analogous to the mel for pitch or the sone for loudness. Yet there is no shortage of verbal descriptions, or of attempts to relate particular timbres to others in some qualitative or quantitative way. Orchestration texts employ many adjectives, such as "rich," "mellow," "thin," "buzzy," "comical," "noble," etc. Quantification may occur through locating a particular tone along a set of dimensions.

In recognition of timbre's multidimensionality, modern attempts to measure timbre usually apply the powerful mathematical technique of multidimensional scaling to uncover underlying dimensions along which one may organize subjects' ratings of the tonal similarity of diverse stimuli. Von Bismarck (1974a,b) analyzed subjects' similarity ratings of a mixture of tones, noises, and steady-state vowel segments and found four factors that explained 91 percent of the variability in ratings. Sharpness, as in one pole of a dull-sharp dimension, was the principal factor. Grey (1977) found three dimensions in geometrical space along which subjects' ratings of a variety of synthesized instrumental tones could be organized: spectral energy distribution, low and high frequencies in the onset, and spectral fluctuations.

While Rasch and Plomp (1982) indicate that multidimensional methodology is essential because there is no way to order timbres on any unidimensional scale, one procedure (Pollard, 1999; Pollard & Jansson, 1982) quantifies timbre by using the loudness in sones of spectral portions of the stimulus, such as the fundamental, the portion containing the second, third, and fourth partials, and the portion containing higher partials. This procedure, which Pollard and Jansson call a *tristimulus* method, arises, in part, from the differential sensitivity of the ear to given intensities across different frequency ranges. One could debate whether the tristimulus method is unidimensional, and whether one really is measuring timbre.

Summary

Chapter 4 presents considerable information related to music's psychoacoustical foundations. The material is inherently complex; simplification is difficult. The following list itemizes the chapter's main points in an aphorismic matter.

1. Musical sounds depend on rapid atmospheric pressure fluctuations resulting from physical vibration, usually regularly recurring or periodic.
2. Pressure fluctuations cause mechanical vibrations in the inner ear, which processes the signals and converts them to electrochemical signals directed to the brain.
3. Tones have physical characteristics (frequency, intensity, waveform, time), which would exist independently of any human observer, and psychological characteristics (pitch, loudness, timbre, duration), which require a human observer.
4. Pitch, a tone's apparent location on a high-low continuum, depends on the physical property of frequency, but the pitch-frequency relationship is not perfect.
5. In addition to its highness-lowness dimension, pitch includes dimensions of definity (how obvious the pitch sensation is), and similarity, circularity, or intimacy (how a particular pitch relates to other pitches).
6. Pitch assignment for a pure tone depends on the area of basilar membrane stimulation.
7. A simultaneous combination of pure tones elicits a sensation of unison, beating, roughness, or two tones, in accordance with the tones' frequency separation.
8. The amount by which a frequency must change in order to elicit a pitch difference varies with the individual, occasion, and frequency range.
9. A complex tone's pitch depends on the low pitch resulting from the waveform's spatial pattern and repetition frequency, detected through the central neural process of fundamental tracking.
10. Combination tones result from cochlear distortion; they are distinguished from low pitch in that they require more than minimal intensity level for perception and are peripheral rather than central effects.
11. Musicians usually consider consonance and dissonance as another label for various intervals, while nonmusicians evaluate intervals in accordance with reaction to intervalic quality.
12. Consonance and dissonance judgments depend heavily on training and experience; some physical basis may exist due to tonal spectrum configurations and/or basilar membrane alignment of tonal components.
13. Why complex tones from separate sound sources generally result in harmony while individual complex tones yield a unitary pitch sensation is unclear.
14. The apparent size of a musical interval of constant ratio may vary with frequency range and other conditions in an idiosyncratic manner.
15. First order beating, an apparent rise and fall in loudness of a mistuned unison, is a peripheral effect.
16. Second order beating, an apparent waxing and waning or fluttering of a mistuned nonunison interval, is a central pitch processing effect.
17. Absolute pitch, the ability to name a tone without reference to any external pitch standard, appears to be related to learning label-sensation connections at a critical age.
18. Attempts to measure pitch as distinct from frequency via the mel scale have been somewhat disappointing, but the mel scale has its advocates.
19. Loudness, the apparent strength or magnitude of a sound, depends largely on intensity, but the loudness-intensity relationship is not perfect.
20. Loudness is distinguished from volume (a tone's apparent size or extensity) and density (a tone's apparent compactness), but recognition of volume and density as separate tonal properties is inconsistent.
21. Decibels are measures of intensity level and sound pressure level (physical properties), not loudness.
22. Equal loudness curves connect frequency-intensity combinations which produce loudness levels equivalent in phons.
23. Equal loudness curves show how frequency confounds the intensity-loudness relationship; a given intensity level does not elicit an equal loudness sensation across all frequencies.
24. One may measure loudness via various techniques; the sone scale, derived from estimations of loudness, may be the best known subjective loudness scale.
25. The power law suggests that loudness grows in a lawful manner in relation to growth in sound intensity; the growth rate varies with stimulus conditions.
26. One sound may mask another; simultaneous masking is particularly important in musical settings.
27. Loudness summation depends on the particular component frequencies, their degree of separation, and relative phase as well as individual loudnesses; there is no simple additive process.
28. Exposure to music at high intensity levels, possibly sought for vestibular as well as auditory pleasures, may reduce hearing sensitivity, sometimes permanently.
29. Timbre depends on the physical factors influencing waveform as well as onset and other transient waveform characteristics.
30. Musical context may be important in recognizing timbre.
31. Tone source recognition depends on learning as well as timbre percep-

tion.

32. As timbre is multidimensional, its measurement beyond qualitative descriptions depends on finding underlying dimensions along which one may place perceptual judgments of individual timbres.

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Chapter 5

RHYTHMIC FOUNDATIONS

The foundations of musical behavior examined in Chapter 5 contrast somewhat with the foundations or perspectives of Chapters 2, 3, and 4. Chapter 2 stresses musical behavior's social and cultural dependence. Chapter 3 examines some functional applications of music in daily life, including ceremony, commerce, narration, therapy, and facilitation of learning. Chapter 4, employing what Sloboda (1985, p. 239) calls a biological approach to music psychology, addresses physiology and basic psychophysical processes involved in perceiving and responding to tonal stimuli.

With due recognition of musical behavior's dependence on sociocultural and biological influences, Chapters 5 and 6 examine the contributions of cognitive psychology to understanding musical behavior. A superficial dichotomy may appear between the study of musical *behavior* and music *cognition,* but the authors, as do most educators and psychologists, recognize that behavior and cognition are integrally related and mutually interdependent. Reasons for various educators, psychologists, and other writers appearing to focus either on *behavior* or *cognition* to the apparent neglect of the other often are deep-rooted, philosophical, complex, and perhaps irrelevant to the present discussion. Since research from both perspectives has made invaluable contributions to understanding musical behavior, the authors have drawn on research from both. However, because of the dramatic surge of interest during the past two decades (e.g., Aiello & Sloboda, 1994; Butler, 1992; Cook, 1999; Desain & Windsor, 2000; Deutsch, 1982, 1999; Dowling & Harwood, 1986; Fiske, 1990, 1993; Hargreaves, 1986; Hodges, 1980, 1996; Howell, Cross, & West, 1985; Lerdahl & Jackendoff, 1983; Serafine, 1988; Sloboda, 1985, 1988; Taylor, 1981), Chapters 5 and 6 seek to apply such contributions to the understanding of rhythmic, melodic, and harmonic behaviors.

Theorists, psychologists, and educators increasingly are devoting efforts to understanding rhythm's role in music and how people interact with musical rhythm. Obviously, diverse approaches to studying rhythm and rhythmic behavior exist. Persons concerned with understanding rhythmic behavior's psychological foundations must scrutinize and synthesize a vast body of diverse literature into a conceptual framework that will provide a basis for understanding the rhythmic behaviors of performers, listeners, and students.

This chapter seeks to help the reader develop such a framework by examining (a) rhythm's function in music, (b) rhythmic structures in music, (c) the role of movement in rhythmic perception and performance, (d) cognitive processes underlying rhythmic behavior, (e) research perspectives on the development of rhythmic behaviors, (f) teaching practices for developing rhythmic behaviors, and (g) approaches to evaluating rhythmic behaviors.

Functions of Rhythm in Music

Rhythm is an essential component of all musics, whether of primitive societies, non-Western societies, traditional Western art music, or contemporary popular styles. As Gaston (1968, p. 17) notes,

> When the musics from all cultures of the world are considered, it is rhythm that stands out as most fundamental. *Rhythm is the organizer and the energizer.* Without rhythm, there would be no music, whereas there is music that has neither melody nor harmony.

Cooper and Meyer (1960, p. 1) also view rhythm as a fundamental organizing component: "To study rhythm is to study all of music. Rhythm both organizes and is itself organized by all the elements which create and shape music processes." Sloboda (1985, p. 188) agrees that rhythm provides an important organizational basis in music and notes that "knowledge of the tonal structure can help determine the rhythmic structure, and *vice versa*." Dowling and Harwood (1986, p. 179) state that "rhythmic information is, if anything, more fundamental to music cognition than pitch information." Carterette and Kendall (1999, p. 780) suggest that using reference pulses and creating musical patterns by unevenly dividing the times between pulses may be among a set of cross-cultural "universals" that enable people to organize sound.

Several writers suggest that rhythm and its various attributes serve functions beyond organization. Benjamin (1984) recognizes three particular functions of musical meter: to (a) provide a way for measuring time in terms of a specific work as it is heard; (b) facilitate the perception of group structure by providing an underlying framework for the melodic phrase rhythm, and, an essentially aesthetic function; (c) provide structural time-points that greatly expand the functional range of interplay between time and pitch.

Mursell (1956, pp. 254–257), whose study and writing concerning rhythm spanned 40 years, maintains that rhythm (a) gives life, sparkle, reality, and expressiveness to musical performance; (b) adds immensely to the pleasure of listening; (c) facilitates musical performance and music reading; and (d) is the best and most natural starting point for musical creation.

Gabrielsson (1982, pp. 159–163) agrees that rhythm in music involves

much more than the performed musical sounds and proposes a general model for what is involved in musical rhythm. For Gabrielsson, musical rhythm involves *musical performance*, which produces *sound sequences*, which in turn may elicit psychological and physiological responses in the listeners. He notes that listeners' responses may be of three types: (a) *experiential*, including various perceptual, cognitive, and emotional variables; (b) *behavioral*, including more or less overt movements such as tapping the beat with one's foot, swaying the body, or dancing; and (c) *physiological*, such as changes in breathing, heart rate, or muscular tension.

Whether as a performer or respondent, an individual's interaction with rhythm in music can result in aesthetic experience (Sachs, 1953, p. 18). Rhythm's increasing importance as an aesthetic device is readily apparent when one compares its prominence and complexity in twentieth century music with its role in much renaissance, baroque, classical, and romantic music.

Despite its importance in eliciting various types of responses, rhythm's primary musical function is to give order. Music is a temporal art that must be organized comprehensibly, and most definitions of rhythm allude in some way to rhythm as music's organizational and dynamic force.[1] Rhythm, in its broadest sense, *"is everything pertaining to the temporal quality (duration) of the musical sound"* (Apel, 1944, p. 640). It is the organization of sound's (and silence's) durational attributes that indeed allows sound to become music. When comprehensible organization is lacking, the listener is not likely to perceive the sound as music.

Rhythm provides music's forward movement, thus making music a dynamic (in the sense of motion and change), energizing force. Music with little rhythmic movement elicits lesser dynamic response than music in which rhythmic movement is active. Rhythm gives "life" to music, and a "feel" or "sense" of rhythm as the dynamic force within music facilitates a person's interactions with music, both as a performer and a respondent.

Even with general agreement regarding rhythm's basic functions in music, there is considerable diversity in the ways people describe the various attributes of rhythmic structure in music. The authors believe that an understanding of these attributes is essential to understanding the psychological foundations of rhythmic behavior, and the next section examines various descriptions of these attributes.

Rhythmic Structure in Music

Descriptions of the attributes of musical rhythm are many and varied. The descriptions employ some commonality of terms, but the terms do not

[1] For discussions of various definitions of rhythm, see Creston (1964) and Behrens (1984).

always have common meanings. Mursell (1937, p. 190), for example, recognizes two attributes of musical rhythm: (a) the underlying beat and (b) the phrase rhythm. Cooper and Meyer (1960, p. 3) recognize three basic modes of temporal organization: (a) pulse, (b) meter, and (c) rhythm. Gordon (2000, p. 32), in a departure from traditional terminology, recognizes "three universal elements of rhythm": *macrobeats, microbeats,* and *rhythm patterns.* For Gordon, *macrobeats* are essentially the same as conventional beats and serve to define tempo; *microbeats* are subdivisions of the conventional beat (into essentially twos or threes) and serve as the basis for determining meter; *rhythm patterns* typically range in length from one to three *microbeats* and when combined in a series form a melody's rhythm (pp. 32, 40).[2] Creston (1964, pp. 1–44), writing from a composer's vantage point and considering rhythm in terms of "the organization of duration in ordered movement," identifies four basic rhythmic aspects: (a) meter, (b) pace, (c) accent, and (d) pattern. Creston views the terms *time* and *tempo* as somewhat indefinite and inaccurate and replaces them with *meter* and *pace* respectively. Most current writers also use meter in place of time, but substitution of pace for tempo is less common. Tempo remains the prevalent term. *Accent* is used in the traditional sense (emphasizing a beat), while *pattern* refers to any subdivision of a pulse or beat into smaller units.

Benjamin (1984, p. 359), however, maintains that *accent* and *grouping* "are the basic, if not neatly separable, modes of partitioning musical time and that meter is a secondary construct, imposed on the interaction of group structure and accent, in response to certain practical and aesthetic needs." Gabrielsson (1973b), based on analysis of data from several experiments, recognizes the following properties of rhythm: (a) meter, (b) the level of accent on the first beat, (c) the type of "basic pattern," (d) the prominence of a basic pattern, and (e) the "uniformity-variation" or "simplicity-complexity" of a rhythm.

As may be apparent, any examination of music's rhythmic structure is somewhat confounded by the fact that discussions of structure, particularly ones such as those by Benjamin (1984), Lerdahl and Jackendoff (1983), Gabrielsson (1973b, 1982), Clynes and Walker (1982), and Dowling and Harwood (1986), necessarily reflect *perceived structure,* albeit in as "objective" a manner as possible. To varying degrees, such discussions treat rhythmic structure both as a psychological phenomenon and as an objective physical (acoustical) phenomenon. Consequently, discussions of structure reflect var-

[2]Gordon formerly referred to *macrobeats* as tempo beats and to *microbeats* as meter beats. Gordon's designation of meter in accordance with *subdivisions* of the conventional beat is unique and contrasts with most definitions of meter, which involve regularized groupings of conventional beats around an accented beat. Gordon also recognizes *time patterns,* which have been likened to harmonic rhythm, but he notes that they "bear no systematic relationship to rhythm patterns or to underlying macrobeats or microbeats" (2000, p. 119).

ious writers' personal and research-based experiences with both the physical structure of notated and performed rhythm and the perception of rhythm, a psychological phenomenon. More recently, Clarke (1987b, 1989) and Pressing (1993) have sought to clarify the differences in rhythm's structural (scientific) and psychological (musical) properties.

Clarke (1987b) recognizes several levels of structure in the organization of time in music. He views written symbols as the lowest level of a hierarchical structure "in which the most abstract higher levels embody the relationships between lower level events" (p. 212). Clarke notes that the temporal properties represented by notation include (a) tempo, (b) the relative durational properties of individual events and silences, (c) grouping relationships, and (d) meter. He points out that pitch, timbre, and dynamics also help to define some grouping boundaries, metrical structures at higher levels than the notated measure, and patterns of tension and relaxation ("directed motion"). He observes that articulation and other changes in durational proportions of notated rhythmic values during performance cause the "idealized durational proportions of a score [to lose] their small whole number property" (p. 213), but argues that these changes are perceived as stylistic interpretations, and that durations between event onsets (i.e., the beginnings of individual tones) are not affected directly. More will be said below regarding differences in notation and performance practice.

Clarke (1989) also sees a gap between descriptions of music's formal structures and the approaches of cognitive psychology and cites three problems in indiscriminately intermixing the two approaches: (a) an assumption that formal structure and perceptual properties function in the same way, (b) the subjective variability of psychological processes, and (c) a tendency to confuse cultural norms with perceptual norms. He recommends that scholars maintain a clear separation between the two approaches while simultaneously trying to establish a rapport between them.

Recognizing that the same dichotomy also applies to the present discussion, the balance of this section includes a somewhat traditional overview of rhythmic structure for the interested reader. Discussions of the cognitive bases of rhythm follow in a subsequent section.

The *beat,* the basic unit of duration, underlies rhythm's structural components by dividing duration into equal segments. While the beat often is called the *pulse,* the authors find it useful to distinguish between beat and pulse. Pulses are time points of infinitesimal length; they occur at the beginning of each beat. Each beat has duration, lasting from its beginning (its pulse) until the beginning of the next beat (the next pulse). Thus, a beat may include four sixteenth notes, but only the beginning of the first sixteenth note coincides with the pulse. Kramer (1988, p. 97) maintains that people "do not literally *hear* beats. [They] experience them, . . . feel them, and . . . extrapolate them."

A problem arises in discussion of beat with respect to meter. Meter signatures ostensibly specify the unit of notation that receives a beat (i.e., fills the time span from one pulse to the next). In practice, however, the unit the meter signature designates as receiving the beat is not always the same as the beat one feels in response to the music, as, for example, in a 3/4 "Viennese" waltz or a 6/8 march at a customary tempo. Mursell (1937, pp. 189–198) uses the German term *Takt* to indicate the felt beat. Farnsworth (1969, p. 233) refers to it as the *true* beat, while still others refer to it as the *tactus,* a fifteenth- and sixteenth-century term for beat. For this discussion, the *metric beat* is that which a meter signature indicates. The beat felt in response to the music is the *true beat.* Instances in which the true beat coincides with the metric beat, as it does in much music, simply are referred to as beats.

Meter involves the grouping of beats, usually metric beats. Just as beats, meter is periodic in that its function is "to mark off the musical flow, insofar as possible, into equal time spans" (Lerdahl & Jackendoff, 1983, p. 19). Meter usually is considered in terms of notation and is commonly indicated by bar lines. The idea is that the first beat of each measure should receive an accent, thus delineating the meter. Obviously, music does not always conform mechanically to this pattern; departure from the norm allows music to be an expressive medium rather than confining it to being mechanical or arithmetic.

Most theories of meter recognize that more than one level of meter may operate within a musical work. Since meter involves grouping of beats, multiple levels of meter are more a matter of perception than structure, and therefore will be examined later in the discussion of meter perception. Here, it is sufficient to note that with rapid tempi, the effect on the listener often is to make the notated measure the felt unit of beat, rather than the metric beat. The listener in turn may group the felt or true beats into multiple measure groupings to create a superimposed meter or *hypermeter.* Examples of hypermeter include collecting one-beat waltz tempo measures into groups of four (ONE two three, TWO two three, THREE two three, FOUR two three; ONE, TWO, THREE, FOUR; as in Strauss's overture to *Die Fledermaus*) and feeling an alternating measure pattern in a 2/2 or 2/4 march in groups of four measures (ONE two, TWO two, THREE two, FOUR two; ONE, TWO, THREE, FOUR; as in the trio of Sousa's "Hands Across the Sea").

In other instances, neither the metric beat nor the measure is the same as he true beat; e.g., 6/8 meter in moderate or faster tempo often is felt in twos, vith the dotted-quarter note functioning as the true beat unit. Jaques-)alcroze (1921, Musical Supplement, p. 1) suggested a plan to make meter gnatures more meaningful and avoid the confusion between the metric and ue beat. The note that represents the beat unit would be substituted for the ›wer number in the meter signature (see Figure 5-1).

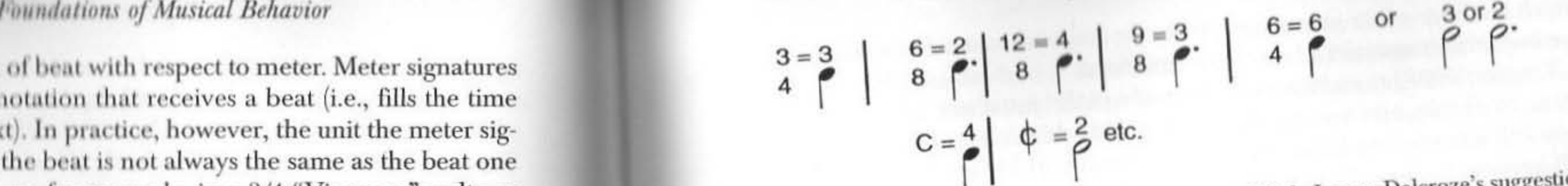

Figure 5-1. Jaques-Dalcroze's rationalized signatures. While Jaques-Dalcroze's suggestion has received some following in recent years, it is far from common practice, and musicians must continue to cope with distinguishing between metrical beat and true beat.

Tempo, or *pace* as Creston terms it, refers to the speed at which beats recur. In music notation, tempo generally is indicated by means of traditional Italian terms, including (from slowest to fastest) *grave, largo, adagio, lento, andante, moderato, allegro,* and *presto.* More precise tempo indications are given in terms of metronome markings, which indicate the number of times a given note value or unit of time recurs in one minute. The indicated note value may coincide with either the metric or the true beat. A typical metronome marking is M.M. = 80.[3] Here, the beat unit, as indicated by the meter signature or a printed note incorporated into the metronome marking, would recur 80 times per minute.

Accent is the rhythmic aspect that makes prominent or emphasizes a beat or some part thereof. Creston recognizes eight types of accents. A *dynamic* accent, probably the most common, emphasizes a beat by means of intensity; i.e., the accented sound is louder than other nearby sounds because of its increased power. An *agogic* accent emphasizes by means of duration: A tone or chord is longer than those preceding or following it. A *metric* accent basically reflects the particular grouping of true or metric beats and often is encompassed within a dynamic accent. A *harmonic* accent emphasizes a beat by use of dissonance or harmonic change. A *weight* accent expresses emphasis through change in texture. A *pitch* accent denotes emphasis on the highest or lowest tone of a group. *Pattern* accents occur on initial tones of repeated melodic figures. *Embellished* accents emphasize a beat by using melodic embellishments, e.g., mordents, trills, or grupetti. Creston views accent as the "very life of rhythm," without which meter becomes monotonous, pace (or tempo) has no sense of motion, and pattern becomes a nebulous elaboration.

Lerdahl and Jackendoff (1983, pp. 30–35) and Benjamin (1984) also provide in-depth discussions of types and functions of accents. They focus more on the role and function of various accents in *grouping* durational events within the total musical structure. However, they carefully delineate between *metric* accents, which reinforce groupings of beats, and other types of accents,

[3]Mälzel constructed the metronome in 1816. M.M. is a standard abbreviation for Mälzel Metronome.

which facilitate other groupings within the musical context as well as serving various other musical and aesthetic functions.

Kramer (1988) maintains that there are really just three types of accents–stress, rhythmic, and metric. He believes that additional accent classifications only call attention to factors that cause accents. What musicians commonly call accents because they require action in performance are stress accents, created by a sharp attack, a high loudness level, an embellishment, etc. Stress accents operate independently of the metric downbeat. Metric accents, which may occur on rests as well as on notes, essentially help define the regular grouping of beats. Rhythmic accents help define rhythmic groups at several levels, e.g., a motive, phrase, period, section, or movement.

Beat, meter, tempo, and, to a degree, accent are the most agreed upon aspects of rhythmic structure. Phrase rhythm, melodic rhythm, rhythm pattern, or rhythm group are some names given to the rhythm of the melody and harmony parts that overlie and/or are intertwined with beat, meter, tempo, and accent. These "overlying" aspects of rhythmic structure constitute an area in which it is quite difficult to separate discussion of physical structure from rhythm as a psychological phenomenon. Whereas beat and meter essentially provide reference points in musical time, tempo refers to the speed at which beats recur, and accent provides a means for emphasizing a beat or some part thereof, a listener may group phrase or melodic rhythm patterns at various levels. Because grouping is a function of both the musical structure and the perceiver's experience, most of the discussion regarding grouping is within the section below on rhythmic perception. However, some descriptions of the basic structural units of melodic rhythm are included here.

Mursell (1937, pp. 176–185) and Cooper and Meyer (1960, p. 6) recognize some basic rhythmic groups called "units," which involve grouping unaccented pulses around an accented pulse as the basic structural level for melodic rhythms. Derived from ancient Greek poetic meter, the five basic units include *iamb* (-^), *anapest* (--^), *trochee* (^-), *dactyl* (^--), and *amphibrach* (^-^-); a dash indicates an unaccented pulse. Theoretically, these units underlie music's melodic rhythm, but Yeston (1976, pp. 27–34) notes several problems in attempting to reduce rhythm to such basic units, particularly when perceptual processes are considered. He maintains that attempts to analyze rhythm into these terms are overly reductive and do not reflect realistic rhythmic variants.

Gordon (1971, pp. 67–71, 1980, pp. 31–58, 2000, p. 40) and Creston (1964, pp. 34–43) view subdivisions of beats as the underlying structural units for melodic rhythms. Both Gordon and Creston agree that beats are subdivided into basically twos or threes. When the beat is divided into two equally spaced subdivisions (which he calls *microbeats*), Gordon labels this duple

meter; when the beat is subdivided into three *microbeats*, he labels it triple meter.[4] Gordon has devised a Taxonomy of Rhythm Patterns that vary from one to three beats (his *macrobeats*) in length and that essentially are comprised of various macro/microbeat patterns and divisions or elongations thereof, although they also include patterns using rests, ties, and upbeats. These rhythm patterns, of which there are nearly 500, are classified according to how they fit into one of several of his devised meter classifications: usual duple, usual triple, usual combined, unusual paired, unusual unpaired, unusual paired intact, and unusual unpaired intact.[5]

Creston refers to subdivisions of beats as *patterns*, which may be classified as *regular* or *irregular* and *simple* or *compound*. Regular patterns reflect subdivisions suggested by meter signatures; irregular patterns are subdivisions not suggested by meter signatures. Repeated patterns are called simple patterns; changing patterns are considered compound.

Regardless of how one labels or describes rhythm patterns, melodic rhythms obviously overlay and entwine themselves in relation to the beat. Melodic rhythms may vary infinitely; they may be even, uneven, use subdivisions of beats, or involve durational values extending over many beats. It is the very freedom of melodic rhythm that provides a primary means for making music a dynamic energizing force.

While melodic rhythm with its free organization in relation to the substructure of beat, accent, and meter provides both variety and unity for musical structure, composers may employ many additional extensions of rhythmic structure to provide even greater interest. The potentials of polyrhythms, multimeters, changing meters, changing tempi, and nonmetrical rhythms, in combinations with the potential for rhythmic variety within conventional rhythmic structure, make rhythmic structure a truly dynamic, integral, and essential part of all music.

Movement and Rhythm Perception and Performance

Traditional definitions and music teachers' conventional wisdom tend to support the view that movement somehow interacts with and facilitates rhythm perception and performance. Over the years, various theories have arisen to account for rhythmic behaviors, and some contemporary psychological perspectives regarding the foundations of rhythmic behaviors postulate "mental timekeepers" and "internal clocks," suggesting that rhythmic behavior is primarily cognitively based. Still others suggest that an integrat

[4]The reader should note that Gordon bases "duple" and "triple" meter on groupings of *subdivision of beats;* conventional references to duple and triple meter are based on whether accented beats ar grouped in twos or threes.

[5]To review Gordon's Taxonomy of Rhythm Patterns, see Gordon (2000, pp. 63–87).

ed dynamic systems approach best accounts for rhythmic behaviors. Despite the diverse perspectives, movement is a part of most theoretical explanations, and this section examines some traditional perspectives regarding movement's role in rhythmic perception and production. It begins with a brief overview of some general theories that address the issues of mental/motor interactions and concludes with a brief discussion of two theoretical perspectives on the relative roles internal timekeepers and dynamic systems approaches, which incorporate movements, play in explaining human rhythmic behaviors.

Piaget, who devoted a lifetime to epistemology, maintains that early sensorimotor learning is the basis of intellectual development and suggests that it provides the framework from which and in which perception itself originates and evolves (Flavell, 1963, p. 472). Hebb's (1958, p. 116) studies of chimpanzees' early sensorimotor experiences support Piaget's view. Chimpanzees whose sensorimotor experiences were limited greatly during infancy were much slower at learning simple tasks than were chimpanzees that were allowed normal sensorimotor experiences.

Views that motor activity aids in thinking are not new. Indeed, early motor theories served as the impetus from which modern views concerning the effect of movement on thinking evolved. The motor theory of thought originally was devised in order to avoid postulating ideation to explain thinking. Over 40 years ago, Hebb (1958, p. 58) noted that while thought involved more than motor activity, theoretical conceptions concerning sensory feedback had continuing validity and importance for understanding serial behavior.

Sensory feedback usually is of two kinds: exteroceptive and proprioceptive. Events external to the body excite exteroceptive sensory cells; body *movements* excite proprioceptive cells. Proprioceptive feedback is of particular importance in understanding rhythmic behavior.

While proprioceptive feedback often is equated with kinesthetic feedback, proprioception long has been the preferred term for feedback from movement rather than kinesthesia. The concept of kinesthesia generally is associated with introspection, whereas proprioception emphasizes neurophysiologically observable receptor and sensory nerve action (Osgood, 1953, p. 29).

Galvao and Kemp (1999) note that proprioceptive feedback "is believed to have a central importance for the development of motor performance of any type" (p. 132). Their review of terminology and issues related to kinesthesia and proprioception, however, points out a longstanding controversy related to use of the two terms. They note that such views have been replaced by an integrated view of mind and body and suggest that kinesthesia might be the more appropriate term because it may refer to "both a sense of movement and static limb position" (p. 131).

Gillespie (1999a), however, notes that it is difficult to dissociate the sense of touch (taction) from that of movement and body position (kinesthesia), and consequently argues for use of the term *haptics*, which encompasses both types of sensory feedback. Gillespie provides an overview of haptics (1999a) and suggests applications in understanding and describing feedback and anticipatory controls in manipulating musical instruments during performance (1999b).

Notwithstanding the views of Galvao and Kemp and of Gillespie, whose discussions are more concerned with general instrumental performance than rhythm performance, the present authors believe that *proprioception* is the more appropriate term for feedback from movement because it involves actions that generate feedback.

The existence of proprioceptive pathways to the thalamus, cerebellum, and cortex is an established fact (Morgan, 1965, p. 258). There are three types of neural receptor cells for proprioceptive sensations (proprioceptors): (a) "spray type" cells at different positions in the joints, (b) Golgi apparatus, and (c) Pacinian corpuscles. These cells actually are in the joints rather than in the muscles. Proprioceptive stimuli may travel to the cortex via either of two routes. The direct route is through the thalamus. The other, more diffuse and indirect, is through the reticular activating system, but Morgan (1965, p. 41) reports that the various sensory inputs and outputs are not clearly separated in the reticular system.

Thus, neurophysiological findings support the contentions that sensory feedback from movement relates to higher mental processes. However, the precise role the proprioceptive impulses play in higher mediating processes is not known. It is, though, subject to speculation.

Osgood (1953, p. 651) says, "It may be that motor tone merely serves as a facilitative agent for mental activity in general." Hebb (1958, p. 69) maintains that thinking can not be accounted for by central processes alone or by muscular feedback alone: Both mechanisms are involved.

At least two theories of perception have movement as one of their bases, and while these theories primarily are concerned with visual perception, the principles involved also apply to perceptions via other sensory media. Hebb maintains that eye movements are essential to visual perception. As he states, eye movements "contribute, constantly and essentially, to perceptual integration, even though they are not the whole origin of it" (Hebb, 1949, p. 37).

The sensory-tonic field theory of perception postulates that both proprioceptive and exteroceptive feedback are essential to perceptual integration (Allport, 1955, pp. 183–207). This theory holds that it can be shown experimentally that sensory, i.e., exteroceptive, and tonic, i.e., proprioceptive, factors are equivalent with respect to their contributions to the dynamic out-

come.

While few contemporary cognitive psychologists would agree with Sperry's (1964, p. 429) emphasis of the dependence of mental on motor activity, there clearly is substantial research evidence that proprioceptive feedback is an important contributing factor for rhythm performance and perception.

In the last decades of the nineteenth century and the early decades of the twentieth century, rhythm perception was investigated frequently. Introspective analysis was the accepted experimental technique of the times; this requires consideration when evaluating the findings concerning movement's (kinesthesia's) value as an aid in rhythm perception.

Ruckmick's (1913) classic and much-cited study of kinesthesia's role in rhythm perception asked subjects to give their impressions of the given rhythm patterns verbally with and without accompanying movement. His conclusions were that (a) rhythm perception may occur without accompanying kinesthesia, (b) individual differences exist in the amount of kinesthesia involved in rhythm perception, and (c) kinesthesia generally is connected most prominently with the initial clear perception of the type and form of rhythm. Much later, Ruckmick (1945, p. 8) explained that the last conclusion meant "kinesthesis [sic] was essential for the establishment of a rhythm pattern." Kinesthesia ceased to be necessary for rhythm perception only after a rhythm pattern was established.

From a review of Ruckmick's and many other early studies concerning rhythm perception, Boring (1942, p. 587) concluded that many perceptions are grouped by concomitant kinesthesia and many are not. "Kinesthesis [sic] is not a *sine qua non* of rhythm."

Moog's (1979) comparison of rhythm discrimination abilities of physically handicapped, mentally handicapped, and normal children supports the contention that movement facilitates perception. He noted that children with movement limitations due to physical handicaps scored significantly lower than normal children on an investigator-constructed measure of rhythm discrimination and concluded that children with movement limitations existing since early childhood do not develop rhythm perception skills to the same extent as normal children.

While consensus regarding an integral relationship of movement and rhythm perception is evident, Gabrielsson (1973b, 1982) and Fraisse (1982), apparently in an effort to avoid a dichotomy, suggest that it might be more appropriate to speak of rhythm *experience* rather than rhythm perception. Fraisse states that "it is necessary not to dissociate motor *behaviors* linked to rhythms from . . . perceptions" and that "the play of music is always based on movements" (p. 175). He later notes that because of the motor component, rhythm perception is in effect "plurisensorial."

Baily (1985, pp. 237–238) notes that music making involves human movement and that the human sensorimotor system is integral to music making. He goes on to argue that to consider music as only a sonic product of cognition fails to recognize the importance of the sensorimotor system in perceiving and performing music.

In recent years psychologists have sought to develop theories to explain rhythm perception and performance, and a particular issue is whether rhythm perception and performance are under cognitive control or whether movement is involved. As Summers (2000, p. 3) states,

> on the one hand, proponents of cognitive approaches have argued for the central [cognitive] control of timing in terms of temporal codes stored in motor programs or internal time-keeping mechanisms. On the other, dynamic systems theorists argue that time is not directly controlled in movement, but rather is an emergent property of self-organising [sic] processes in the neuromotor system itself.

Desain and Windsor (2000, p. xii) note that rhythm perception and production are linked to acts of synchronization in studies that ask people to coordinate movements (usually tapping) with an external stimulus (usually a metronome-like pulse). Much of the research and theory is based on subjects' abilities to maintain a steady beat after the external pulse is discontinued. While musicians might find this research base quite limiting, psychologists have used the procedure to develop theories of rhythm perception and performance, and the authors believe they have relevance to the present discussion.

Beek, Peper, and Daffertshofer (2000) recognize two broad theoretical approaches to explaining rhythmically timed movements: *timekeeper models* and *linear oscillator models*.Timekeeper models, part of a class of motor programming theories which in turn are a subset of information processing theories and cognitive constructivism, have two basic aspects: a central controlling system (timekeeper) and a controlled system (movement execution system). Such models postulate an "internal timekeeper" and attempt to explain asynchronies of tapping a single rhythm, steady beat, or pulse following the cessation of an external pulse. "The sole variables of interest are time intervals, i.e., intertap intervals and asynchronies" (p. 14), which "are assumed to be the product of an internal clock or timekeeper that generates motor commands at regular intervals" (p. 14). The clock and motor processes are considered "uncorrelated stochastic processes," and the observed temporal variability provides the basis for inferring the timekeeper's nature. A limitation of the timekeeper model is that it is concerned only with the stability of synchronized timing performance (p. 15).

Nonlinear oscillating models consider "rhythmic movement and the phys-

iological processes that accompany it as manifestations of dynamic pattern formation or self-organization" (Beek, Peper, & Daffertshofer, 2000, p. 15). Reflecting a dynamic systems approach to understanding movement coordination, it "derives its emphasis on pattern formation and self-organization from synergetics, the interdisciplinary approach to complex behavior in physical, chemical, and biological systems" (p. 15). The dynamic systems approach takes into account the contributions of behavioral, neural, and neuromuscular levels of activity to rhythmic movement. In essence, the dynamic systems approach is much broader and yields considerably more information than timekeeper approaches.

Beek, Peper, and Daffertshofer (pp. 27–29) note that attempts are under way to combine the two approaches, particularly to accommodate cognition into the dynamic systems approach. As yet, these approaches are still in process and have not been applied to descriptions of rhythmic behavior.[6]

Todd, O'Boyle, and Lee's (1999) "sensory-motor theory of rhythm, time perception, and beat induction" is an example of a dynamic systems approach to modeling rhythmic behaviors:

> The essence of the sensory-motor theory is that the experience of rhythm is mediated by two complementary representations: a sensory representation of the motional-rhythmical properties of an external source, on the one hand, and a motor representation of the musculoskeletal system on the other. . . . The systems, by learning, tune into the temporal-motional properties of the physical environment, whilst the motor control system, also by learning, tunes into the dynamic properties of its musculoskeletal system. (p. 26)

Todd, O'Boyle, and Lee claim the theory offers a plausible account of several aspects of time psychophysics without postulating the existence of an "internal clock," for which they say no direct evidence exists.

Clarke (1999, p. 495) suggests that the relationship between rhythm and movement can be considered from two perspectives, with rhythm and timing seen either as the *consequence of* movement or as the *motivation for* movement. Issues related to the former essentially are those described by Beek, Peper, and Daffertshofer (2000), who focus on the timekeeper versus dynamic systems approaches to modeling rhythmic behaviors. Citing Shaffer (1982, 1984), Clarke suggests that response might be influenced by some internal clock mechanism and that rhythm patterns "are produced by overlearned motor procedures that specify movement patterns that have as their consequence a definite timing profile. Timing properties are thus the consequence of movement rather than a control parameter in their own right" (p. 495).

[6]Readers interested in further information regarding the theoretical models and approaches are encouraged to review several articles in Part I of Desain and Windsor (2000).

Clarke's second perspective, which considers rhythm and timing as the motivation for movement, essentially suggests that highly rhythmic music tends to elicit accompanying motor responses involving two subsystems, one for "relatively rapid periodic phenomena (foot tapping) and the other associated with slower and less restricted periodic movements (body sway and whole body movement generally)" (pp. 495–496). Whether Clarke's views accommodating both approaches will be accepted by other psychologists remains to be seen.

So, what do such theories have to do with understanding the role of movement in rhythm perception and production in music? At the risk of oversimplification, the models controversy appears to provide a theoretical and academic examination of the issues related to cognitive (central) versus proprioceptive and other peripheral (subcortical levels) contributions to control and direction for rhythm performance and production.

Cognitivists likely will continue to maintain that rhythmic behaviors are under central control, but most musicians, music teachers, and proponents of dynamic systems approaches recognize that proprioceptive feedback is useful, and perhaps essential, for clarifying rhythm perception and performance.

Cognitive Perspectives on Rhythmic Behavior

The authors consider movement an essential contributor to rhythm perception and performance, but they also recognize that rhythmic behaviors involve cognition. This section examines some of the growing body of research related to the role of cognition in rhythmic behavior.

In recent years, rhythmic behavior has become a topic of considerable interest to psychologists, most of whom are concerned with explaining or modeling rhythmic behavior from a contemporary cognitive perspective. Most contemporary psychologists view rhythmic behaviors, and indeed most musical behaviors, as under cognitive control, and explanations often involve the development of theories or models of the cognitive processes underlying rhythmic behaviors. Such models usually include some type of *cognitive controller* (e.g., motor programs, internal clock, or timekeeper) and a movement execution system (or *plant*, in the current parlance of control theory) (Summers, 2000, pp. 3–5). Others take a broader view of cognition reflecting some type of *dynamic systems approach* that involves postulating one or more nonlinear oscillators functioning in coordination with the complex attributes of the neural, neuromuscular, and sensorimotor systems involved in rhythmic behaviors (Beek, Peper, & Daffertshofer, 2000, pp. 15–27). A dynamic systems approach "ultimately aims at a multilevel theory of brain and behavior that elucidates the connections between pattern formation in the brain (or, more generally, the nervous system) and the formation of behavioral patterns" (Beek, Peper, & Daffertshofer, p. 27).

Proponents of dynamic systems approaches take issue with *formalist* approaches, notably that offered by Lerdahl and Jackendoff (1983). Eck, Gasser, and Port (2000, pp. 158–160) argue that formalist approaches are overly dependent on symbol systems (notation) and fail to account for continuous timing properties of real performed music. They cite four ways in which the temporal organization of performed music differs from the integer ratio-based time relationships found in notation: (a) *performance noise* (inconsistencies in synchronizing tapping or performing with an external rhythmic stimulus), (b) *expressive timing* (purposeful deviations from notation), (c) *tempo invariance* (ability to make reliable downbeat predictions over a wide range of tempi), and (d) *preferred tempo* (making changes in metrical interpretation of a piece to keep the beat in a comfortable range). In short, Eck, Gasser, and Port argue that sensitivity to real time is critical to one's ability to perceive and perform music.

Despite such objections, Clarke (1999, p. 478) notes that Lerdahl and Jackendoff's (1983) *Generative Theory of Tonal Music* was a particularly significant contribution to the understanding of rhythm perception because of its distinction between grouping and meter.

A number of other researchers (e.g., Drake, 1998; Drake, Jones, & Baruch, 2000; Drake, Penel, & Bigand, 2000) also recognize the importance of the breakdown of rhythm into grouping and meter, although they refer to them as *segmentation into groups* and *temporal regularity extraction* (Drake, 1998, p. 13). The theoretical framework for their research is Jones's (Jones, 1976, 1987, 1990; Jones & Boltz, 1989) *dynamic attending theory,* which Drake, Jones, and Baruch (2000, pp. 253–263) conveniently and succinctly summarize. Jones's dynamic attending theory is a type of dynamic systems approach intended to account for how people conceptually organize their responses to music's temporal aspects. The present discussion draws heavily on the work of Drake et al., but, contrary to Drake et al. and Clarke's accounts, it treats beat/tempo perception separately from meter perception.

Although most rhythmic behavior involves interaction with music as a more or less holistic, integral part of musical behavior, this section examines the research and related writings as they pertain to (a) beat/tempo perception, (b) meter perception, (c) perception of rhythm groups, and (d) expressive timing in music. Prior to examining current theory and research regarding cognitive perspectives on rhythmic behavior, we review some longstanding, albeit noncognitive, theories proposed to account for human interaction with rhythm.

Early Noncognitive Theories

Early psychology of music literature recognized three classes of rhythm theories–instinctive, physiological, and motor. Lundin (1967, pp. 116–122) proposed a fourth theory, which emphasized the role of learning in the development of rhythmic behaviors. The instinctive theory, of which Seashore (1938) was a major proponent, held that "there are two fundamental factors in the perception of rhythm: an instinctive tendency to group impressions in hearing and a capacity for doing this with precision and stress" (p. 138). This theory reflects the position that rhythmic potential is inherited, not learned. A number of studies, however, suggest that training can improve rhythmic potential (or, for Seashore, "capacity"), thus disconfirming the theory (e.g., Coffman, 1949, p. 74; Lundin, 1967, p. 114; Nielson, 1930, p. 78).

Physiological theories suggest that rhythmic responses relate to the rates of recurring physiological processes. Belief that the human heart rate is a basis for musical rhythm and tempo has been most prevalent; Jaques-Dalcroze (1921, pp. 79–82) was an avid proponent of this view. More recently, Parncutt (1987, p. 130) suggests that *prenatal conditioning,* through which a fetus hears sounds associated with a mother's heartbeat and walking movements, might be the process by which infants develop a responsiveness to such periodicities. He also observes a similarity in the range of heartbeat and footstep rates and those of strongly felt musical pulses, somewhere around 0.8 to 0.5 sec (75 to 120 beats per min). Evidence to support the heart rate theory, however, is lacking, and Lund (1939) reported no significant relationships between college students' preferred tempi for selected popular songs and the rate of any of their objectively measured physiological processes. Recent research on beat and tempo perception, discussed below, also offers little or no support for physiological theories. While the "natural" rhythms of human physiology, including the menstrual cycle and cyclic changes in body temperature, wakefulness, and biochemistry, may influence a person's *receptivity* to musical stimuli, they are too lengthy, complex, and variable to explain rhythmic responses to relatively short-term musical stimuli.

The motor theory holds that rhythmic behaviors depend on the action of the voluntary muscles, i.e., proprioceptive feedback as discussed above, and most early writers on music psychology concurred. Schoen (1940, p. 21) notes that nearly all investigations concerning the nature of rhythmic experiences find a motor or muscle factor, thus supporting motor theory advocates. Mursell (1937, p. 162) and Lundin (1967, p. 106) both agree that the motor theory is the most plausible of the traditional theories, but neither accepts it without reservation. Mursell argues that neuromuscular movement does not function in isolation from the human brain; rather, music functions in conjunction with the brain and central nervous system. Lundin, although essentially an S-R psychologist, also views rhythmic behavior as involving both perceptual and behavioral responses.

Lundin's (1967, pp. 106–113) account of rhythmic response also recognizes the importance of learning. For Lundin, learning rhythm involves perceptual *discrimination among* and *organization of* rhythmic stimuli, as well as

production of rhythmic behaviors. He goes on to argue that overt motor rhythmic responses (production behaviors) reflect the *clarity* of an individual's perceptions. While all may not agree with Lundin's view of what is involved in learning rhythm, few would deny the role and importance of learning in the development of rhythmic behaviors.

Beat/Tempo Perception

Most music is organized around underlying, regularly recurring beats, which musicians simply call *beats* and which psychologists often call *beat periods.* The onset of a beat is considered a time point (pulse), and the time between the onset points is variously called the *beat, beat duration,* or *beat period.* Most people are able to "feel" the underlying beat (really its onset or pulse) if the beat is sufficiently prominent in the music. This felt beat often is called the *true beat, Takt,* or *tactus.*

Feeling or perceiving beats also implies the perception of tempo, the rate at which beats recur in music. This is important, because beats divide time into a series of reference points around which listeners and performers organize their rhythmic responses and performances. Dowling and Harwood (1986, p. 186) maintain that beats serve as a "cognitive framework" for perception of rhythm. If listeners and performers can not feel and respond to the underlying beat, their perceptions (and behaviors) related to rhythms may be impaired.

Fraisse (1982, p. 149) argues that rhythmic perception also depends on tempo, "because the organization of succession into perceptible patterns is largely determined by the [Gestalt psychology] law of proximity." If a tempo becomes too slow, the forms of both rhythm and melody become difficult for a listener to discern. When a performer is unable to feel or perceive a piece's tempo, the performed rhythm patterns become disjointed from the overall temporal structure. In short, it appears that rhythmic response and performance are seriously deficient for individuals who are unable to feel and respond to the underlying beat. Of course, tempo often determines what one feels as the underlying beat or as a higher level of metric organization.

Research related to beat perception, which sometimes is called beat induction or *beat abstraction,* comes from several perspectives. These may include assessing accuracy in synchronizing tapping with an external metronome-like stimulus and continuing the tapping once the stimulus ceases (e.g., Eck, Gasser, & Port, 2000; Madison, 2000; Todd, O'Boyle, & Lee, 1999; Wohlschläger & Koch, 2000), examining responses to changes in tempo (e.g., Duke, 1989; Franěk, Mates, & Nártová, 2000; Geringer, Duke, & Madsen, 1992; Geringer, Madsen, & Duke, 1993/1994; Sheldon & Gregory, 1997), and examining factors that influence beat perception (e.g., Drake, 1998; Drake, Jones, & Baruch, 2000; Drake, Penel, & Bigand, 2000).

Many psychologists and theorists consider the beat as just one level of metric organization. Other recognized levels may include subdivisions of the beat, the measure level (usually groupings of beats into twos, threes, or fours around an accented beat), and several higher levels that involve groupings of measures (*hypermetric levels*). Notwithstanding the realities and importance of the other levels of temporal regularity in music, the authors concur with Fraisse (1982) and Dowling and Harwood (1986) that beat/tempo perception is fundamental to the other levels, and therefore warrants primary and separate consideration. Again, the reader is reminded that tempo is an important determinant of what people feel and respond to as a beat (i.e., the true beat, *Takt,* or *tactus*), which often is not that indicated by a meter signature.

Obviously, the range of tempi that people feel or perceive as a beat (i.e., that to which they might tap more or less spontaneously) varies from individual to individual, and, as will be discussed, with age level, musical experience, and musical structure. However, Fraisse (1974, 1982) observed that many adults have a more or less natural propensity to tap spontaneously (i.e., with no external stimulus) with an inter-onset interval somewhere between 500 and 600 milliseconds (ms) (120 and 100 beats per minute (bpm)). When he asked them to tap to music "at an appropriate rate," they also tended to tap within this general range.

Geringer, Duke, and Madsen's (1992) study of influences on musicians' beat note perception also revealed a tendency to tap within a limited range of tempi. They found tempo to be an important variable, noting that musicians have a propensity to tap to periodic rhythmic stimuli with an inter-onset interval between 500 and 1000 ms (120 and 60 bpm). For stimuli outside this range, subjects tended to double or halve tapping rates so that they fell within the comfortable range of 500 and 1000 ms.

Although Drake and her colleagues (Drake, 1998; Drake, Jones, & Baruch, 2000; Drake, Penel, & Bigand, 2000) maintain that people may perceive temporal regularity in music hierarchically (i.e., at various levels, including subdivisions of beats, beat level, measure level, and several hypermeasure levels), Drake (1998, p. 14) notes that most listeners spontaneously focus on events occurring "at regular intervals at an *intermediate rate,* corresponding to the rate at which you find yourself tapping your foot when listening to music." She goes on to observe that extraction of an underlying pulse appears to be "universal in nature." Drake calls this intermediate rate (the beat) the *referent level,* and notes that for most adults it probably is in the range of a 600 ms inter-onset interval (100 bpm).[7]

[7]The reader should remember that the *greater* the inter-onset interval, the *slower* the tempo in beats per minute (bpm). For example, a 600 millisecond (ms) inter-onset interval equals a rate of 100 bpm; a 400 ms inter-onset interval equals a rate of 150. Most psychologists report tapping data in milliseconds, but most musicians are more comfortable with beats per minute, which conforms to standard metronomic indications.

Drake, Penel, and Bigand (2000) investigated the effects of several aspects of performance microstructure (slight variations in timing, intensity, and articulation) on 36 adults' (18 musicians and 18 nonmusicians) abilities to extract or respond to an underlying beat. Using six recorded excerpts of Western tonal music with tempi ranging from M.M. = 90 to 150, they presented each excerpt in three ways: "mechanical (synthesized from the score, without microstructure), accented (mechanical with intensity accents), and expressive (performed by a concert pianist with all types of microstructure)" (p. 1). Jones's *dynamic attending theory* served as the theoretical base for the study, which sought three types of information: (a) ease of synchronization (Jones's *attunement*), (b) each subject's spontaneous synchronization rate (i.e., *referent level*), and (c) range of additional metric levels at which subjects could respond (*focal attending*). Subjects were asked to tap in synchrony with each presentation.

As might be expected, subjects were better able to synchronize taps with the mechanical and accented versions than with the expressive versions; musicians generally were more accurate in the synchronizations (i.e., attunement with the beat) than nonmusicians. When asked to tap at rates other than the referent level, musicians were more prone to tap at slower rates (i.e., at higher metric levels) than nonmusicians, thus reflecting more effective focal attending. Finally, musicians tapped at higher metric levels for the expressive versions than they did for the mechanical and accented versions. Of particular interest regarding beat/tempo perception is the fact the mean spontaneous synchronized tapping (referent level) was much slower for musicians (mean inter-onset interval = 1042 ms, mean tempo = 58 bpm) than for nonmusicians (mean inter-onset interval = 858 ms, mean tempo = 70 bpm).

In a subsequent study, Drake, Jones, and Baruch (2000) examined differences in age and musical training (two respondent-related variables) on *attunement, referent level,* and *focal attending.* The investigators compared performances of 4-, 6-, 8-, and 10-year-old children and adults, with and without musical training, on seven different tasks. Three tasks involved spontaneous tapping with no external rhythmic stimulus (tapping at a "comfortable" rate, as fast as possible, and as slow as possible), three "forced" tapping tasks required synchronization (tapping with isochronous sequences at five different tempi, with rhythmic sequences at five different tempi, and with the first thirty measures of Ravel's *Bolero*), and the other task involved tempo discrimination. The investigators tested nine 20-subject groups, one for each age-musical training combination, with the exception of musically trained four-year-olds, who were too few in number.

The researchers computed mean spontaneous tapping rates (i.e., without an external stimulus), interpreted as measures of the *referent period,* for the five age levels. Adults tapped at about a 600 ms rate (100 bpm), which was

consistent with Fraisse's earlier prediction for adults. Four- and six-year-olds tapped considerably faster (400 ms inter-onset interval, 150 bpm); eight- and 10-year-olds tapped at rates between 500 and 550 ms inter-onset interval (120–110 bpm). Musicians at the six-, eight-, and 10-year-old levels tapped significantly slower than nonmusicians. In short, tapping rates slowed significantly as age increased, and musicians tapped significantly slower than nonmusicians.

Forced tapping ranges, which were used to define the range of motor tempi, increased dramatically as a function of age and musical experience, without a significant interaction; i.e., older and musically experienced subjects were able to tap much faster and slower than younger and less musically experienced subjects. Noting the dramatic increases in the range of forced tapping rates with age, along with only a modest change (decrease) in spontaneous tapping rates, the investigators concluded that spontaneous tapping rates capture the limits of referent period attending and forced tapping rates capture the limits of focal attending (p. 269).

Tempo discrimination also improved significantly as a function of age, particularly for discrimination tasks at slower tempi. Analysis of variance revealed significant main effects for tempo (with better discriminations at intermediate tempi) and size of tempo change. Considering these data in conjunction with forced tapping data, the investigators concluded that "limits observed in tapping tasks are not strictly motoric but include a perceptual component as well" (p. 270).

Responses to three types of synchronization tasks (tapping to *Bolero,* rhythmic sequences, and isochronous sequences) reveal that subjects at all age and experience levels accurately synchronized tapping with *Bolero* and that synchronization improved with age and musical experience for the isochronous and rhythmic sequences. However, a significant interaction occurred between age and type of sequence; children generally were successful in synchronizing tapping with isochronous sequences (means > 70%), but mean synchronization scores for rhythmic sequences were much lower for younger children, reflecting a clear developmental pattern.

Mean synchronization rates slowed significantly with age, although no significant differences were observed between musicians and nonmusicians. Mean synchronization rates, grouped across the three types of stimuli, ranged from 533 ms (112 bpm) for six-year-olds to 905 ms (66 bpm) for adults.

Spontaneous tapping rates were considered reflections of the *referent period,* while synchronized tapping rates were considered reflections of the *referent level.* "Mean synchronization tempi were somewhat slower than spontaneous tapping rates, indicating that listeners are drawn towards longer time spans than their referent period when establishing a referent level" (p. 275).

Data regarding *focal attending* tasks, i.e., responses at hierarchical metric levels other than the referent level, also yielded changes with age and musical training. Young children tended to tap most directly with the beat (referent level), but older children increasingly tapped at higher metric levels. Musicians tapped at higher metric levels than nonmusicians for *Bolero* but not for the isochronous and rhythmic sequences.

In summarizing their results, Drake, Jones, and Baruch note that the different groups of subjects "do not appear to perceive the sequences in the same fashion" (p. 283). The main differences are related to age, with adults focusing spontaneously on events at intermediate rates (600 ms inter-onset intervals). Young children focus spontaneously on events at faster rates (400 ms inter-onset intervals) and are much more limited in their range of accessible tempi. "With age, we find a gradual slowing of the rate at which listeners spontaneously focus, and a proportional increase in the range of tempi at which listeners can tap, synchronize, and perform temporal tasks" (pp. 283–284).

Drake, Jones, and Baruch theorize a biological orientation to understanding the development of rhythmic behaviors and consider "attentional oscillations as inherently biological activities and entrainments as primitive ways of linking an animate thing to the world" (p. 284).[8] They note that the entrainment properties of adaptive oscillators "place certain biological constraints" on attending and learning, and acknowledge that "factors other than perceptual, such as motor planning and control, may influence participants' performance on our tasks" (p. 284).

Several researchers have examined tempo perception as a separate entity, and while such research, sometimes called *tempo modulation* research, does not focus on the beat per se, it does explore variables that may influence beat perception. Kuhn (1974) observed that professional musicians could identify decreases in the tempo of beats produced by a metronome more easily and more quickly than increases in tempo. Subsequent studies by Geringer and Madsen (1984) and Wang (1984), which examined tempo perception in a musical context, yielded results consistent with Kuhn's finding that tempo decreases were easier to perceive than tempo increases. A surprising sidelight of both studies was that no significant differences existed between music majors' and nonmusic majors' responses.

Several studies have examined the effects of selected variables on tempo perception and preference. Wang (1983) examined the effects of rhythm pattern, texture, beat location of tempo change, and direction of tempo change on the amount of time college students need to perceive tempo change. Besides noting that tempo decrease is easier to perceive than tempo increase, she observed that significantly more time was needed to perceive tempo change for uneven rhythms than for even rhythms and for melody alone than for melody with accompaniment. Her data also suggest that differential rhythmic groupings may influence tempo perception.

Wang and Salzburg (1984) examined the influence of music training and age on 116 string students' abilities to perceive tempo change. Subjects identified whether or not a tempo change occurred, and, if so, the direction of change. Data revealed a statistically significant curvilinear relationship between tempo perception and music training and between tempo perception and age. Subsequent regression analysis indicated that musical style, initial tempo, and direction of change also contributed significantly to tempo perception, leading the investigators to conclude that tempo perception is a complex phenomenon, for which parameters are not yet identified.

Killian (1985) investigated college music majors' (a) tempo performance accuracy across repeated trials under differing feedback conditions, (b) tempo perception accuracy after performing and hearing a recording of the performance, and (c) relationship between verbal perception and tempo performance. The three feedback conditions included performance results only, performance plus a prerecorded metronome standard before the next trial, and control. Data revealed no statistically significant effects of condition on tempo performance, but subjects receiving feedback improved their tempo perception accuracy. The relationship between performance and perception accuracy was analyzed by examining frequency of agreements between performance and perception, and overall there was a low percentage of agreement between performance and perception scores (32.5%).

Two other studies examined various influences on the perception of beat note change in modulating tempos (Geringer, Duke, & Madsen, 1992; Geringer, Madsen, & Duke, 1993/1994). The 1993/1994 study, essentially a replication and extension of the 1992 study, examined when the beat note pulse of musical tempo became too fast or too slow to be felt as a musical beat. Data from 85 graduate and undergraduate music majors revealed that the direction of the change and the stimulus timbre were significant influences on subjects' indications of changes in beat note pulse. Tempo decreases were identified more readily than tempo increases. The data also supported earlier research indicating that musicians tend to perceive beat tempi within the approximate range of 60 to 120 bpm (65 to 115 for this particular study).

Sheldon (1994) examined the effects of three variables (tempo, musical experience, and listening mode) on tempo modulation perception.

[8] This essentially is a dynamic systems approach, which assumes that a self-sustaining internal oscillator exhibits a stable cycle or periodicity, which they call a *limit cycle* (p. 253). Self-sustaining oscillation "may synchronize, i.e., entrain to time intervals in [a] rhythm by adapting its phase and period" (p. 253). The investigators refer to such oscillators as *adaptive*.

Comparing the Continuous Response Digital Interface[9] responses of 80 music majors and 80 nonmusic majors, she observed that music majors were significantly better at identifying tempo changes than nonmusic majors and that "overall" subjects were better at detecting tempo acceleration than deceleration, a finding contrary to those reported above. Also, subjects were less efficient in identifying tempo changes when watching a conductor while listening than when listening alone or listening and moving.

In a subsequent study, Sheldon and Gregory (1997) found that subjects with greater educational experience were more adept at detecting tempo modulation (both increases and decreases) than less experienced subjects. Furthermore, their results support earlier findings that experienced subjects are able to recognize changes in tempo deceleration more readily and accurately than changes in tempo acceleration.

To summarize, beat/tempo perception is basic to rhythmic processing. The perception of regularly recurring beats provides a cognitive framework for rhythmic perception and performance. However, perceptual accuracy does not guarantee performance accuracy. Tempo perception and performance are complex phenomena and are influenced by, or at least related to, a number of stimulus and perceptual variables. Tempo per se of listening examples has an influence on respondents' abilities to identify tempo changes. Decreasing tempi are easier to detect than increasing tempi. The rhythmic density of the prominent melody in a musical excerpt has a particularly strong influence on children's and nonmusicians' detection of tempo changes.

Trained musicians appear to have a propensity for tapping both spontaneously and in synchrony with musical excerpts at slower rates than children and less experienced musicians, apparently reflecting ability to perceive temporal regularity events in large chunks. They also perceive periodic rhythmic stimuli in terms of a limited range of tempi. The work of Geringer, Duke, and Madsen documents the propensity to double or halve rates of periodic stimuli so that they fall within 60 to 120 bpm. This tendency to group beats to fall within a perceptually manageable range, however, may be as much a matter of meter perception as beat/tempo perception.

Meter Perception

Musicians, educators, and psychologists generally agree that meter perception involves grouping beats, usually in relation to an accented beat. In traditional Western music, meter is periodic, and while some may argue that

[9]The Continuous Response Digital Interface (CRDI) is a device with which observers can indicate perceived changes in a stimulus property (such as tempo) as they monitor the stimulus (such as ongoing music).

the measured groupings of beats provides a rigidity leading to a metronomic, unmusical performance and response, Benjamin (1984) makes an eloquent case for just the opposite view. He argues that metric structure, especially when considered at multiple levels, in larger units, and in greater depth, provides a predictable yet supple ordering of time in which to relate ongoing musical events. As Gabrielsson (1988) notes, musicians often alter beat relationships in the interest of musical style and expression, and metric relationships provide a framework for such alterations.

While response to the beat is considered the fundamental response to temporal regularity in music, response to music's meter, or grouping of beats, is considered hierarchical (e.g., Drake, 1998; London, 1995). London considers metric organization at the levels of beat subdivision, the beat, the measure, and several possible hypermeasure levels. Drake considers the true beat to be the basic level of metric organization, but also recognizes beat subdivisions and several possible higher levels. Drake's levels, which allow for levels that incorporate multiples of the beat into larger units (e.g., measures and several possible hypermetric levels), are more dependent on psychological factors than notation or music theory-based factors.

Numerous theories, some music theory-based and others psychologically-based, have been offered to account for how people respond to music's metric organization at levels other than the beat. Review of all such theories is beyond the scope of the present discussion, but readers are encouraged to see Clarke's (1999, pp. 482–489) excellent review of several prominent theories. Clarke's review includes theories of Povel and Essens (1985), Longuet-Higgins and Lee (1982), Lee (1991), Johnson-Laird (1991), Parncutt (1994), Desain (1992), Large and Kolen (1994), and Todd (1994a, 1994b). In concluding his review, Clarke notes that "meter is not just an auditory and cerebral phenomenon; it also has an important motor component" (p. 488). He also notes that models of meter based solely on temporal information (as were the ones he reviewed) are limited and one dimensional, and argues that models of meter need to incorporate both temporal and accentual information.

Windsor (1993), following some earlier work by Clarke (1987a), suggests that meter perception is categorical and interdependent on dynamic accents and perceived metric structure. Based on the results of three experiments in which he varied the accents to suggest patterns ranging from clear metric patterns to ambiguous patterns to clear nonmetric patterns, Windsor obtained data supporting Clarke's contention that meter is perceived categorically. He concluded that "dynamic accents and their metrical interpretation are truly interdependent, regularity in the former leading to a metrical interpretation that guides the pick-up of further accents" (p. 138).

As noted above, notation creates some problems relative to meter per-

ception in that beats and meter indicated by notation may not conform to the beats and meter that listeners perceive or "feel." Tempo appears to be a primary variable in determining whether a perceived or felt grouping of beats conforms to a notated grouping.

R. Jones (1985) notes that perhaps a greater concern than the tempo/notation issue is in the contradictions regarding how metric patterns are perceived or subjectively organized, and his analysis of five theories or approaches to defining meter provides at least a partial resolution to some contradictions. Theories examined include what he terms a traditional music theory definition and those offered by Cooper and Meyer (1960), Yeston (1976), Gordon (1971, 1980), and Serafine (1975). The traditional theoretical definition tends to focus on groupings of beats in terms of notated measures, but inherent differences frequently exist between what is notated and what is perceived.

Cooper and Meyer (1980) and Yeston (1976) both recognize that metric groupings may occur at more than one level. Cooper and Meyer emphasize "architectonic" levels of meter and suggest that meter usually is present at three levels. Their primary level is that at which beats are counted. Subdivisions of the primary level are considered lower level meter; units of the primary level are combined to form higher level meter. Jones views their theory as an elaboration and extension of the traditional definition and criticizes it for not considering tempo's influence on the selection of levels. Also, the theory appears to focus more on visual than on aural perception and analysis.

Yeston's theory recognizes that meter is periodic and depends on at least two rates of rhythmic motion that interact relative to each other. The fastest levels, termed *foreground*, are grouped by the slower motion, termed the *background*. Any intermediary levels are called *middlegrounds*. Yeston's complex system of analysis allows melody and harmony to play a major role in determining which metric level is considered dominant. Jones views the system as essentially an analytic tool that offers only limited insight into aural perception of meter.

Gordon's theory primarily emphasizes subdivisions of the traditional beat. The subdivisions, called *microbeats*, are the primary basis for his hierarchy of meter and rhythm. The hierarchy, which is theoretically rather than empirically based, has two main categories, *usual* and *unusual;* classifications into the categories depend on various groupings of *macrobeats* and *meter beats*. The system has value for those who follow Gordon's particular instructional system and are willing to disregard traditional terminology and concepts of meter. Many musicians, however, are unwilling to think of duple and triple meter primarily in terms of subdivisions of the basic beat. R. Jones (1985) and Brink (1983) criticize the theory from several other perspectives: its the-

oretical rather than empirical basis, its failure to accommodate adequately higher levels of metric groupings, and its inconsistencies with musical practice. Readers should see Gordon (2000) for a current account of his theory.

Serafine (1975, p. 32) defines meter as essentially the equivalent of beat, apparently in an effort to avoid cultural bias as reflected in the proclivity of traditional Western music to be grouped in twos or threes. Jones (1985) argues that such a theory has little value for conceptualizing metric music and maintains that equating pulse with meter adds unnecessary semantic confusion to the research literature.

Jones's synthesis of his theoretical analyses is that "metric groupings occur at the level of the basic beat, as well as at levels of subdivisions and multiples of that beat" (p. 54). He notes virtually unanimous agreement about the frequent inconsistency of meter signatures with meter and rhythm perception and performance and suggests exploring the relationship between tempo and meter perception.

Madsen, Duke, and Geringer (1986) examined 100 musicians' note preferences for excerpts of eight relatively familiar orchestral works in which dotted notes, which ordinarily are subdivided into three, were presented at original tempi and at tempi 12 percent faster or 12 percent slower. Excerpts purposely were ambiguous regarding whether a typical listener likely would feel them in a fast three or a slow one. When tempi were faster, subjects tended to select the dotted note as the beat unit; when tempi were slower, they tended to select the subdivision of the dotted note as the beat unit. These results suggest that tempo is a primary variable in determining beat units and metric groupings. At faster tempi, listeners tend to do more grouping; at slower tempi, they tend to respond to smaller metric units. Apparently the same perceptual phenomenon observed for tempo perception operates for meter perception.

Butler's (1992) observations about how musicians tap polyrhythmic patterns such as two-against-three, three-against-four, or two-against-five-against-seven, which in effect are akin to cross-meter patterns, reflect a similar phenomenon. He notes that when respondents are faced with more complex patterns, they tend to tap along with the slowest stream. He also observes that respondents "are facile at shifting from one rhythmic level to another" (Butler, p. 160).

Perhaps the work of Drake and her colleagues, discussed previously, holds the most promise for understanding response to music's metric structure. While they recognize that most listeners spontaneously focus on temporally regular events at the beat level (Jones's referent level), they demonstrated that response to metric structure is hierarchical. With increased musical experience and sophistication, listeners tended to focus on higher levels of metric structure (Jones's focal attending). The theory considers responses to

the higher levels as reflecting future-oriented cognitive processing and responses at a level below the referent level (at subdivisions of the beat) as reflecting analytic attending. An important aspect of Jones's theory, demonstrated in the research of Drake et al., is that the individual listener determines his or her initial level of response to temporal regularity (the beat or referent level), not notation. As the listener's musical experience and sophistication increase, the referent level (what the listener responds to as beat) may change.

Both theory and research suggest that listeners may perceive meter at different levels, and tempo appears to be a particularly important influence on the level at which it is perceived. Dynamic accents also greatly influence meter perception. Perhaps even more important variables, as demonstrated by the theory and research of Jones, Drake, and their colleagues, are those related to the perceiver's musical experience and training.

Rhythm Groups

While the ability to group isochronous beats into meter and lower levels of meter into higher levels appears to depend primarily on tempo and the listener's musical experience, the ability to group nonisochronous musical duration events into rhythm patterns appears to be a function of several variables, some of which relate to musical structure and others of which relate to the listener's experiences. As Davies (1978, p. 197) notes, rhythm groups "are properties of people, as well as musical sounds." While the musical stimuli may be grouped objectively in a given way, they never really are grouped until perceived as such because perceptual grouping ultimately is a psychological phenomenon.

Sloboda (1985, pp. 28–30) maintains that perceptions of durational pattern are *categorical;* i.e., experienced listeners tend to perceive aurally presented rhythm patterns (as well as pitch patterns, discussed in Chapter 6) into *categories* consistent with previously experienced rhythmic (and pitch) groupings. He draws an analogy to the manner in which people, apparently universally, organize basic speech sound classes called "phonemes" into perceptual categories. Although a given phoneme's sounds may vary slightly across multiple hearings, people perceive the hearings as the same and as functionally equivalent. As with all cases of categorical perception, some flexibility in stimulus boundaries allows placement of slightly different stimuli within identical categorical boundaries.

To support categorical perception, Sloboda cites data indicating that accurate perception of slight deviations from musical rhythm is quite difficult and notes that performers rarely are able to imitate another's performance *exactly* (p. 30). Sloboda cites Sternberg, Knoll, and Zukofsky (1982), who showed

that highly trained professional musicians were unable to reproduce nonstandard subdivisions of a beat accurately, although they were very accurate in reproducing traditional subdivisions of a beat. He suggests that while training will enable musicians to discriminate subtle rhythmic differences, most people do not experience them as such; they perceive the rhythms in terms of previously experienced categories and most likely subconsciously experience the subtle rhythm differences as differences in performance quality or style.

In ensemble performance situations, asynchronization (i.e., lack of exactly simultaneous onset times for simultaneously sounding tones) is inevitable, yet listeners may experience very precise attacks. According to Rasch (1988), people may overlook differences in onset times of up to 80 ms, even though they can detect 20 ms differences when judging whether a click, tone, or noise comes first. Of course, differences in rise times and intensity differences among tones may be partly responsible, in addition to categorical perception.

Clarke's (1987a) study of categorical rhythm perception strongly supports Sloboda's assertion that the perception of rhythm groups is categorical. He presented 10 music students with short melodic sequences in which the durations of the penultimate and ante-penultimate tones varied systematically between equal duration values (1:1 ratio) and a 2:1 duration ratio, with seven intervening values, none of which conformed to either 1:1 or 2:1 ratios. The subjects indicated whether variously randomly ordered sequences belonged to the 2:1 or the 1:1 ratio class and discriminated between replications of paired sequences. Data from both identification and discrimination tasks provided strong evidence that subjects perceived a real categorical distinction between the two rhythm types. Clarke suggests that "we perceive duration relationships between notes as belonging to two basic classes: *even* and *uneven* divisions of a metrical timespan . . . [and that] the position of the categorical boundary between the two classes is dependent upon the metrical context" (Clarke, 1987a, p. 30). Clarke argues that categorical perception allows one to separate essential structural units or events from nonstructural information. He considers the former to be *invariants of a perceptual context* and the latter to include the *expressive* information. He maintains that

> the separation of temporal information into a domain of structure and a domain of expression resolves the apparent paradox that small whole number duration ratios are the simplest to perceive and reproduce, but that real human performances do not conform to the integer proportions. (p. 31)

Lerdahl and Jackendoff (1983, p. 13) note the importance of rhythmic grouping by stating that once a listener "has construed a grouping structure

for a piece, he has gone a long way toward 'making sense' of the piece." They maintain that grouping is the "most basic component of musical understanding."

Rhythm groups, just as metrical groups, are hierarchical in that listeners may subsume "surface structures" or patterns into larger and more abstract "deep structures," based on combinations of durational structures, as well as melodic, harmonic, textural, and extramusical information. (There are some similarities between this line of reasoning and Chomsky's (1957, 1965, 1968) seminal work regarding deep structures in language and Schenker's (1935/79) theoretical system for conceiving musical structures as outgrowths of an underlying musical core or *Urtext*.) Sloboda's (1985) text is both an introduction to and a detailed treatment of the cognitive organization of music on the basis of abstracted structures.

Many attempts to model hierarchical perceptual structuring of music exist. West, Howell, and Cross (1985) provide an excellent review, and they make five general observations and offer three specific principles for developing models of perceived structure (pp. 45–48). Their observations and principles provide an overview of what such models are trying to accomplish and demonstrate relevance to perception and cognitive organization of music.

Their first observation is that anything in the music that can be perceived may influence perceptual groupings. Neither pitch nor rhythm alone determines grouping and hierarchical organization; different sorts of musical information may conflict and interact. Second, listeners bring prior experiences to the musical encounter. Whatever organizational components emerge for listeners must be in terms of scales, idioms, rhythms, and other personally meaningful aspects. Third, even sophisticated listeners will not immediately perceive, organize, and classify all music in a detailed, well-ordered hierarchy. A composition's distinctive features may change with repeated listening. West, Howell, and Cross's fourth observation is that the organizational structure resulting from applying a model to a particular piece should be verifiable in terms of particular listeners' behaviors. Particular structural preferences should be predictable. Finally, extramusical or historical context may influence structural grouping, as when lyrics demand linguistically sensible phrasing or when instrumental characteristics restrict possible performance options.

Their first specific principle is that models must account for both vertical and horizontal structures because music often involves a string of concurrent events across time. Second, good continuation, proximity, similarity, regularity, symmetry, and common fate, grouping principles encompassed by Gestalt psychology,[10] could be a significant part of a model. Grouping is suggested by various sounds' locations, repetitions, and sequential movements. Lastly, groups formed from Gestalt principles may form larger groups at higher hierarchical levels. "Dominant" events within a larger group, such as accents, dynamics, or prominent pitches, may subsume other events and be "dominant," or other events may subsume them into a higher-order group. A lengthy sequence of sounds may be just one grouping at the highest level, while more and more subgroupings exist at increasingly lower hierarchical levels.

[10]Organization of stimuli into meaningful patterns by applying grouping principles is the basis for Gestalt learning theory. For more information, please see Chapter 10.

One of the most elaborate models, inspired in part by psycholinguistics and grammar, is that of Lerdahl and Jackendoff (1983). They propose four hierarchical components (rather like conceptual skeletons) in the structure of a musical composition. Essentially, the components differ in their organizational bases. Two components, *metrical structure* and *grouping structure*, primarily are concerned with durational structure, whereas the other two components, *time-span reduction* and *prolongational reduction*, focus on pitch structures. Of relevance to the present discussion, *grouping structure* suggests that the continuous stream of musical events is segmented, from three- or four-event (note) motives into phrases and larger sections. Certain rules of the Lerdahl and Jackendoff theory, *well-formedness rules*, which specify *possible* structures, and *preference rules*, which designate the *probable* structures that are likely to conform to the way experienced listeners organize the music, govern grouping structures. The preference rules specify principles that appear to govern the establishment of group boundaries. They include principles of (a) proximity and change; (b) parallelism, which states that musical segments construed as parallel should hold equivalent in the grouping structure; and (c) symmetry, which suggests preferred subdivisions and groupings of segments into two parts of equal length. In essence, Lerdahl and Jackendoff's rules recognize that both nondurational aspects of musical structure, such as attack, articulation, dynamics, and registration, and more global considerations, such as symmetry and motivic, thematic, rhythmic, and harmonic parallelism, may influence grouping structure (Lerdahl & Jackendoff, 1983, pp. 43–55).

Barela (1979) recognizes three elements of a rhythmic group: upbeat or anacrusis, accent, and afterbeat. Lerdahl and Jackendoff prefer the term anacrusis over upbeat and define it broadly to include the "span from the beginning of a group to the strongest beat in a group" (p. 30). An accent, often termed a structural accent because it results from some nonmetrical event such as pitch, dynamics, or texture, reflects that focal point of a rhythm group to which the events of the anacrusis point. Following the accent are the rhythm group's afterbeat, which Lerdahl and Jackendoff prefer to call the extension of the group.

Empirical testing of theories of rhythmic grouping such as that of Lerdahl

and Jackendoff is virtually nonexistent, and if cognitive theories of musical processing are to gain and maintain credibility, they must be validated empirically. An obvious limitation of the Lerdahl and Jackendoff theory is its formalist basis, i.e., its seeming overemphasis on musical structure at the expense of concern for understanding the psychological processes involved. Although the bulk of research on cognitive processing of music has been concerned with melodic rather than rhythmic processing, a limited amount of research concerning perception of rhythm groups exists, and studies providing data relevant to some of the variables underlying rhythmic grouping are examined here.

Drake's (1998) theory, which overcomes some of the limitations of formalist theories such as that of Lerdahl and Jackendoff, focuses on the processes involved in temporal organization of music. Besides the processes of basic temporal regularity extraction and hierarchical metric organization discussed in the previous section, she identifies two processes related to rhythmic grouping: *segmentation into groups,* which she considers a basic process, independent of age or culture, and most likely universal, and *hierarchical segmentation organization,* which involves integration of small basic groups into increasingly larger units–ultimately whole phrases and entire pieces. The latter process involves complex higher level grouping that appears to vary with age, musical experience, and culture. She maintains that her approach differs from that of Lerdahl and Jackendoff "by proposing real-time perceptual and cognitive processes that contribute to the creation of these complex representations" (Drake, p. 17). Her theory emphasizes *processes* involved, not *mental representations* of a perceived structure.

Drake reports both perceptual and performance data to support her breakdown between *basic segmentation* and *hierarchical segmentation organizational* levels. For a simple reproduction task, she reports data showing that five-year-olds, seven-year-olds, and adult nonmusicians and musicians made essentially the same systematic timing distortions (lengthening a time interval) between basic rhythm groups. In a related perceptual task designed to show that the timing distortion was perceptual rather than motor, data revealed that subjects could more easily detect lengthening of time intervals within basic rhythm patterns than between rhythm patterns.

To demonstrate that musical experience influences hierarchical segmentation organization, she asked 12 young violinists to learn a novel piece over a five-week period. Using "relative lengthening of events" during performance as the basis for identifying perceptual groupings, a comparison of the mean timing profiles revealed dramatic differences in rhythmic groupings between week one and week five. The violinists essentially divided the 32-measure piece into eight four-measure segments in week one, but by week five, they clearly divided the piece into two 16-measure segments, which Drake cites as

evidence of increased hierarchical segmentation as a result of musical experience. While she cautions that critical tests of her hypotheses are needed, she maintains that her data raise questions about some rules underlying hierarchical structures of both familiar and unfamiliar music.

The temporal order in which sounds occur may be overridden in perceptual organization of rhythm patterns. *Auditory stream segregation,* in which auditory input is organized into two simultaneous patterns on the basis of common elements rather than strict temporal order, and rhythmic *fission,* in which alternating tones form two separate melodic rhythms, are interesting cases of rhythm which are not uncommon in music.

When Bregman and Campbell (1971) presented a short cycle of six tones (three high and three low) at a rapid rate, their subjects invariably divided the sequence into two streams on the basis of frequency. The patterns actually perceived were those which related elements in the same subjective stream. The perceptual split depended on the frequency difference and presentation rate; faster presentation rates required less difference between high and low tones in order to induce the streaming effect.

Auditory stream segregation on the basis of frequency differences is more likely when the tones are short and discrete. Frequency glides between the tones and longer tones result in a continuity which makes the temporal order easier to follow and discourages stream splitting (Bregman & Dannenbring, 1973).

Rose and Moore (2000), basing their work in part on the theory of Beauvois and Meddis (1996), suggest that auditory stream segregation due to frequency differences partly depends on the overlap of excitation patterns on the basilar membrane and/or the distance between peaks of those patterns. They identify two frequency separation boundaries. If the frequency separation between successive sounds is less than the *fission boundary,* the listener always hears a single stream. If the separation is greater than the *temporal coherence* or *fusion boundary,* the listener always hears separate streams. When successive frequency differences fall between the smaller fission boundary and the larger fusion boundary, the listener may or may not experience auditory stream segregation.

Dowling (1968) illustrated rhythmic fission by presenting tone sequences, at about 10 tones per second, which were constructed so that frequency differences between *successive* tones were *large* while differences between *alternate* tones were small. Melody was detected among alternating tones of the same intensity and frequency range, especially when observers were directed in their listening. Intensity differences and stereophonic separation between the patterns strengthened rhythmic fission.

In a later study, Dowling (1973) showed that two familiar melodies formed by alternating successive tones ("interleaved" melodies) are identified easily

as the result of melodic fission when the two melodies' frequency ranges do not overlap. When frequency ranges do overlap, the task is more difficult, although listeners can track a familiar melody if it is prespecified, i.e., they know the melody in advance. All melodies were altered to a rhythm of alternating quarter notes and quarter rests, and the combined tonal sequences ("interleaved" melodies) were presented at a rate of eight tones per second.

The organization of auditory streams is context dependent; e.g., widely separated frequencies may be in one stream if other stimulus elements are noises. Two organizational principles, one of element similarity and one of temporal proximity, may conflict. Basically, auditory streams appear to form in such a manner that elements within a stream are maximally similar (McNally & Handel, 1977).

Much speculation and limited research have considered whether rhythm patterns are more easily perceived in isolation or in a total musical context. Individual claims regarding which presentation mode is easier vary, and research apparently is inconclusive. Sink's (1983) summary of research on the effect of context yields no clear-cut conclusion regarding the effects of context. Petzold (1966) reported no significant differences in children's abilities to perform rhythm patterns presented in melodic or monotonic contexts, but Gabrielsson (1973b) and Moog (1979) both reported data suggesting that melodic information interfered with the processing of rhythmic information. Boisen (1981), however, reported no statistically significant effects of melodic context on 2,207 seventh, ninth, and eleventh graders' perceptual judgments of rhythmic completeness or incompleteness. On the other hand, Schellenberg and Moore (1985) reported that 57 music majors' and 57 nonmusic majors' memory for rhythm patterns was significantly better for patterns presented in a melodic context.

Obviously, data could vary for many reasons, but it appears that the matter of context is not simple. In an effort to examine the issue systematically, Sink (1983) studied the effects of rhythmic and melodic alterations on rhythm dissimilarity judgments of university music students. Her melodic alterations included monotony, M-shaped melodies, and V-shaped melodies; she used nine rhythmic alterations. Her results indicated that both melodic and rhythmic alterations affect dissimilarity judgments.

To gain further information regarding rhythmic judgments, Sink (1984), recognizing rhythm's multidimensionality within music's broad multidimensional structure, investigated the influence of (a) structural aspects underlying auditory processing of monotonic melodic-rhythmic patterns and (b) selected musical experiences on 38 university music students' rhythmic processing. Dimensions identified as possible organizers of rhythmic information included tempo, meter, rhythmic patterning, and melodic patterning. Subjects' experiential variables examined included ensemble experience, listening habits, and musical preferences.

Sink's data suggest that tempo, duration and pitch characteristics, melodic and rhythmic phrase patterning, and monotony are organizers of rhythmic processing. Major performing instrument and classification of major performing instrument also affect the importance of particular dimensions significantly. Analysis of variance data revealed a slight effect of "generic style" music listening preference, music course experiences, and hours of music listening. Sink concluded that "the importance of each organizer for subjects depended in part on the objective ordering of rhythmic and tonal information, and in part on past music experiences, particularly instrumental training" (p. 190).

Gabrielsson's (1973a) earlier multidimensional analysis of the dimensionality of rhythmic patterning also revealed that tempo was a primary dimension in similarity and dissimilarity ratings. His analysis also suggested that pattern density, which he labeled "rapidity," was another underlying dimension for processing melodic-rhythmic patterns.

Research by Duke (1994) further supports tempo's importance in similarity and dissimilarity judgments. Using 240 third-, fourth-, and fifth-grade children and 80 undergraduate nonmusic majors as subjects, Duke asked subjects to make same/not same judgments for paired performances of four-beat two-pitch rhythm patterns. Experimental test items comprised pairs in which the same rhythm pattern was presented at a different tempo. Control items included pairs in which identical patterns were presented at the same tempo and pairs in which different patterns were presented at the same tempo. Data from comparisons for items with patterns presented at different tempi revealed that both tempo and direction of tempo change affected the same/not same comparison. The mean number of correct responses was significantly lower for the slowest tempo than for the items presented at faster tempi, and subjects were better able to identify "same" patterns when the second presentation of the pattern was faster than the first presentation.[11]

To summarize, the perception of rhythm groups in music is both categorical and hierarchical. Rhythm groups contain three basic components: an anacrusis, a structural accent, and its extension. Theory suggests that certain perceptual laws, particularly Gestalt laws, operate in rhythmic processing. Multidimensional analyses and other research suggest that the extent to which individuals perceive rhythm groups as groups is a function of both musical structure (particularly tempo but also all of its interacting rhythmic, melodic, harmonic, dynamic, textural, and articulation events) and the listener's experience. Theories such as those of Lerdahl and Jackendoff (1983)

[11]If people indeed are more sensitive to tempo decreases than to increases, a faster performance of an otherwise identical pattern should be more similar than a slower performance.

and Drake (1998) attempt to encompass the effects of such structural and experimental variables, but systematic, empirical validation of such theories is lacking, perhaps because isolating the effects of the myriad of variables that underlie how a listener groups rhythm patterns is difficult and complex.

Expressive Timing

Musicians long have recognized that "musical," "expressive," or "artistic" performance involves more than just playing the right notes at the right time. Such performance, referred to simply as expressive performance in the present discussion, necessarily involves deviations from metronomically or mechanically regular rhythmic performance. The work of Bengtsson and Gabrielsson, using their RHYTHMSYVARD computer program, provides clear documentation that professional musicians systematically vary their performances from the mechanical norm (Bengtsson & Gabrielsson, 1980, 1983; Gabrielsson, 1973b, 1982, 1985, 1988). Their data support the hypothesis that "performance of musical rhythm is characterized by certain systematic variations (SYVAR) relative to some kind of norm" (Gabrielsson, 1985, p. 70). Their work provides empirical evidence that musicians vary performances by (a) changing the time ratios between notated values, (b) placing notes before or after underlying metric beats, and (c) elongating phrase endings. They argue that such variations enable both performers and listeners to experience musical rhythm beyond the structural level; these variations from the mechanical norm contribute to the experience of the *motional* and *emotional* dimensions of rhythm. In short, these variations contribute to music's expressiveness.

Research on expressive timing may be grouped into three broad categories: (a) placement, duration, and ratios of tones within a structural framework; (b) effect of structure on expressive timing; and (c) shaping of a *ritardando* or *accelerando.* The classical work of Bengtsson and Gabrielsson with the accompaniment of the "Viennese" waltz, which usually is performed with a "short first beat" and an "early and elongated second beat," clearly exemplifies research in the first category. Gabrielsson maintains that the "too early second beat" is not meant to upset the three-part division of the measure; rather, it is to "contribute to the unmistakable motion character of a Viennese waltz" (1985, p. 79). Research examining musicians' and nonmusicians' preferences for versions of the Viennese waltz accompaniment (i.e., with various note placements and durations on beats one and two) revealed that experienced musicians clearly prefer the version that approximated the note placements and durations of the traditional "Viennese" waltz accompaniment (Bengtson & Gabrielsson, 1983). Apparently, musicians learn through experience the stylistically appropriate or "correct" deviations from the notated norm.

Bengtsson and Gabrielsson's study of systematic variations in the performance of the theme from Mozart's *Piano Sonata in A Major* (K 331) revealed several deviations from the notated time values. In performances of the theme, which is in 6/8 meter, the dotted-eighth/sixteenth/eighth notes consistently were performed with elongated first and third notes and a shortened second note, and quarter/eighth patterns usually were performed at about a 1.75:1 ratio rather than the notated 2:1 ratio. Performance profiles for the Mozart theme also revealed considerable lengthening of tones in the theme's fourth and eighth measures, thus suggesting that musical phrasing concerns clearly override metronomic regularity in expressive musical performance.

Traditional rhythm performance in jazz idioms deviates from notated values. Perhaps the most common deviation is the dotted-eighth/sixteenth pattern. The notation implies a 3:1 ratio between the notes, but in practice the norm appears to be about a 2:1 ratio. Rose (1989) examined other aspects of the timing of a jazz rhythm section and observed that beat duration changed with the musical context. He also observed that individual onsets across the section varied in time but occurred in a similar order: The drums usually were first, then the piano, and finally the bass. Systematic variation from the notated norm clearly is an accepted part of jazz performance style.

Clarke (1982) used a Bechstein piano equipped with photocells measuring hammer movement linked to a computer to analyze the performance of Erik Satie's *Vexations* by two graduate music students. The music consisted of three measures, played repeatedly, with some variation in order. Individual repetitions could be performed at different tempi, with the restriction that a steady tempo be maintained with the repetition. Examining the relationships between tempo and rhythm, Clarke observed that phrase lengthening and acceleration away from phrase boundaries indicated structure and groupings. At slower tempi, performers grouped the music into smaller divisions, and the effect of phrase lengthening became more pronounced. Clarke concluded that rhythmic grouping partly depends on tempo.

In analysis of performances of another Satie work, *Gnossienne no. 5,* Clarke (1985) sought to create a model of how expression changes the underlying structure of beats. After examining the performance of various beat subdivisions, he concluded that expression can alter a performance by (a) expanding or contracting the interval between beats or (b) altering the length of individual notes or groups of notes.

Repp's (1990) statistically detailed analyses of 19 famous pianists' performances of a Beethoven minuet revealed patterns that support Clarke's work. Although Repp's intent was to obtain data to support a hypothesized "Beethoven pulse," allegedly involving a systematic alteration in the dura-

tions of three even quarter notes and several other beat subdivisions, his data revealed no underlying "Beethoven pulse" in the 19 pianists' performances. However, the most prominent rhythmic deviation he observed was phrase lengthening, particularly at moments of harmonic and melodic tension, which clearly exemplified expressive timing. His analyses agreed with Clarke's findings that slower performances tend to emphasize phrase boundaries while faster performances tend to focus more on other expressive deviations.

Phrase lengthening is perhaps the most accepted method for expressive timing in musical performance. In practice, performances by music teachers and recordings of professional musicians provide models of expressive *ritardandos, rubato,* and *accelerandos* for students to emulate. Whether all models are equally expressive is doubtful; experts might agree that some timing changes are more expressive than others, and this assumption has given rise to a limited body of research regarding the shape of expressive timing changes in music. Several models for ritards have evolved from this line of research.

Sundberg and Verillo (1980) examined the final ritards in 24 recordings of harpsichord music and found that they generally could divide the ritards into two phases, an initial irregular phase and a second phase that essentially reflected a linear profile. Further analysis revealed several relationships: (a) ritard length is proportional to cadence length, (b) phase two length relates to final motive length, (c) the rate of tempo decrease depends upon the pre-ritard mean tempo and phase two length, and (d) the last measure tempo correlates with the pre-ritard mean tempo.

Feldman, Epstein, and Richards (1992) compared examples of tempo changes in five musical excerpts, including works of Stravinsky and Tchaikovsky, and the barter chant of Yanomami Indians from Venezuela. The excerpts were chosen for their unusual length of tempo change and their natural musical execution. Each excerpt was fitted to three mathematical equations relating rate of tempo change to time within the excerpt: linear, quadratic, and cubic.[12] The results indicated that all of the tempo changes could be modeled by equations accounting for either a linear or parabolic force, resulting in a quadratic or cubic ritardando or accelerando. This suggests a measurable and definable paradigm for beautiful, natural sounding tempo changes.

Johnson's (1996) study of 48 musicians' and 48 nonmusicians' ratings of

[12]In a linear (straight line) relationship, one variable increases (or decreases) at a constant rate as another increases (or decreases). In a quadratic (inverted U) relationship, one variable increases for a while and then decreases as another increases. In a cubic relationship, rather like sawteeth when graphed, one variable alternately increases and decreases systematically while another variable increases.

the appropriateness of rubato usage in four renditions of an excerpt from Mozart's *Concerto No. 2 for Horn and Orchestra* revealed considerable differences in response according to level of musicianship. The four renditions, selected from 13 recordings by experts, included the two rated "most musical" and the two "least musical." The most proficient musicians' rubato ratings agreed with the experts' ratings, while less proficient musicians' ratings disagreed substantially. Nonmusicians' assessments were haphazard. Johnson concluded that the use and perception of rubato in performance is an important but subtle dimension in separating the finest performances from the ordinary.

In a subsequent study Johnson (1998) investigated the effects of instruction in the use of onset timings in computer-generated "performances" of an excerpt from the same Mozart horn concerto. All performance parameters other than onset timings were computer controlled. Thirty subjects were taught the rhythmic tendencies identified in the "most musical" performances of the 1996 study. In a pretest-posttest design, subjects used "significantly more rubato in the posttest performance and that usage more closely reflected the model performance" (p. 436).

In another study, using a two-group, pretest-posttest design, Johnson (2000) further confirmed that one can teach rubato usage. "Bouree No. 1" from Bach's *Suite No. 3 for Solo Violoncello* was programmed into a computer, and both control and experimental subjects prepared and recorded performances with which they were satisfied. Experimental subjects received a model and other information reflecting the aggregate of 15 professional cellists' rubato usage in performance of the work to practice and incorporate into their posttest performance. Only the experimental group's posttest performances correlated significantly with the model.

Expressive timing as a dimension of expressive performance continues to receive increasing interest from both performers and researchers. Space precludes an exhaustive examination of the growing body of research, but readers desiring more information are encouraged to examine studies by Todd (1985, 1989, 1992) and Repp (1992a, 1992b) and reviews by Clarke (1999, pp. 492–494), by Gabrielsson (1999, pp. 532–550), and in Part IV of Desain and Windsor's (2000) *Rhythm Perception and Production.*

Development of Rhythmic Behaviors

Rhythmic behaviors include a broad spectrum of behaviors, ranging from simply tapping the toe in time with the beat to sightreading intricate rhythms to the subtleties of expressive timing. The development of rhythmic behaviors has been the subject of much speculation, research, and trial and error. This section examines selected research findings and music teachers' views

regarding rhythmic development. In addition, it reviews approaches to measuring rhythmic behaviors.

Research on the development of rhythmic behaviors basically is developmental or experimental. Developmental research can be either longitudinal or cross-sectional. Longitudinal studies usually investigate a given group's rhythmic abilities (or whatever trait one wishes to study) over an extended period of time, whereas cross-sectional studies compare a trait in different groups at various age or developmental levels. Although longitudinal studies are the preferred methodology, nearly all studies of rhythmic development are cross-sectional. Few involve study of a given group for more than one year.

Developmental Research

With few exceptions, most developmental research regarding rhythmic behaviors examines the ability either to (a) keep time with a musical beat or (b) repeat or perform given rhythm patterns. The variables in the different studies are numerous, making it difficult to understand clearly the status of rhythmic behaviors at different age or development levels. Some studies also examine rhythmic behaviors in conjunction with behaviors related to pitch organization.

Studies of infants' rhythmic development, however, necessarily involve a research strategy different from the types just mentioned. The investigator must observe the infants' rhythmic behaviors, either freely emitted or in response to rhythmic stimuli.

Several studies (Allen, Walker, Symends, & Marcell, 1977; Chang & Trehub, 1977; Demany, McKenzie, & Vurpillot, 1977) indicate that infants respond to differences in rhythm patterns. Infants apparently tend to habituate to a recurring pattern, but when a change occurs, they respond. One study used eye movement as a measure of response to change; the other two used heart rate.

Moog (1976, pp. 39–40) observed that infants begin responding to music with overt movements between the ages of four to six months. He notes that infants do not move in disorganized clumsy ways; rather, they use clear repetitive movements, related to the rhythmic aspects of the musical stimulus. As the child develops, the movements increasingly are coordinated with both the musical rhythm and dynamics. The movements of the four- to six-month-old infant often involve whole-body movements, but as the child develops, the overt rhythmic responses change, particularly to include more movements of individual body parts. Moog reports that by the age of 18 months, about 10 percent of children are able, for short stretches of time, to match their movements to the music's rhythm.

Sloboda (1985, p. 200), however, questions whether infants during the first

year of life actually are able to demonstrate overt purposeful rhythmic behaviors. He particularly questions some of Moog's results and suggests that much of the alleged rhythmic behavior reflects a high degree of inference by an adult observer. Before he would accept infant movements as "rhythmic behaviors," he would expect them to reflect clearly one or more of the following: (a) moving or beating in time to music, (b) imitating a given rhythm pattern, (c) subdividing a beat, or (d) omitting a beat and then resuming it in correct time after a pause (pp. 200–201).

Studies of rhythmic behavior in early childhood, childhood, and into adolescence show a general refinement in rhythmic skills with increasing age. Jersild and Bienstock (1935) examined two- to five-year-old children's abilities to beat time to music. Seventy-four children's responses were analyzed, and a large increase in scores was evident between ages two and five. Of 400 possible beats (administered in smaller segments), the number of correct beats for the two-year-olds was 84.5; three-year-olds, 109.4; four-year-olds, 159.9; and five-year-olds, 192.8.

Rosenbusch and Gardner (1968, pp. 1271–1276) studied five- to thirteen-year-olds' abilities to reproduce four different rhythm patterns. Comparisons of responses across four age groups (5–7, 7–9, 9–11, 11–13) showed a significant decrease in errors with increasing age.

Gardner (1971) studied first, third, and sixth graders' abilities to reproduce twenty rhythm patterns, each including from four to eight taps. The significantly different ($p < .01$) respective means of correctly tapped patterns for the three groups were 7.35, 13.00, and 16.00.

In an extensive study (Petzold, 1966, pp. 184–251), elementary school children reproduced rhythm patterns found most frequently in seven elementary basal music series published between 1953 and 1959. Patterns were about two measures long and in 2/4, 3/4, or 6/8 meters. The children also responded to a "Periodic Beat Test," involving series of beats at four tempi. The test presented each beat twice, in such a way that the respondent moved from a fast tempo through three successively slower tempi; a second part of the test reversed the tempo order. With usable data from 331 children on the "Rhythmic Patterns Test" and 241 children on the "Periodic Beat Test," Petzold found a plateau at about the third-grade level for both pattern repetition and ability to maintain a steady tempo.

Taylor's (1973, pp. 44–49) study of the musical development of children aged seven to eleven also revealed increases in rhythmic responsiveness for the younger children. He reports statistically significant differences between the younger groups' mean rhythm scores but not between the means of the two oldest groups.

Examining children's norms on some standardized rhythm aptitude tests provides another perspective on rhythmic development with age. Bentley

(1966b, p. 116) reports a "fairly steady increase from year to year" on the rhythm memory portion of his *Measures of Musical Abilities* (1966a). Normative data for about 2,000 boys and girls aged seven through fourteen support his statement. There is a mean yearly increase from 3.9 for seven-year-olds to 8.8 for 14-year-olds. Normative data for the *Seashore Measures of Musical Talents* (1939, 1960) and Gordon's *Musical Aptitude Profile* (1965, 1988) also reflect score increases with age level, even though both tests purport to measure factors that are little influenced by training.

A series of studies by Pflederer and Sechrest (1968, pp. 19–36), testing Piaget's theories of conservation,[13] tend to support the position that rhythmic behaviors (meter and rhythm) are a function of development. Foley (1975), however, reports data suggesting that training can expedite conservation.

Bamberger (1982), who primarily was concerned with how children conceptualized a rhythm pattern, had children ranging from four to ten years of age draw a picture of a familiar nursery rhyme so that they could remember it or another child could clap it. The four- and five-year-olds tried to duplicate the clapping motion, resulting in swirling scribbles. The six- and seven-year-olds tended to draw figural representations of individualized claps, whereas the oldest children tended to group the claps in metric fashion. The effects of learning were apparent in the oldest children's responses, but an important finding was how the young children tended to make the drawings as nearly like the clapping behavior as possible; they were unable to deal with the patterns as abstractions.

Grieshaber's (1987) critical review of research on children's rhythmic tapping also supports the view that rhythmic behaviors improve with age. However, she notes many methodological problems, especially the inherent problems in using clapping tasks as measures of rhythmic behavior in young children, who often lack the coordination to perform anything beyond the simplest tapping task.

Developmental research does not provide clear-cut answers to all questions regarding the development of rhythmic behaviors. The issues are confounded by variables in research design, the type of rhythmic behaviors studied, and reliability and validity of various measures. At best, we can conclude that rhythmic behaviors generally increase with age, although they tend to reach a plateau in older children. However, to unquestioningly believe that increases in rhythmic abilities are solely a function of age or developmental level disregards both the body of research concerning the development of rhythmic behaviors through experimental learning experiences and the

[13]Conservation refers to the invariance of a particular dimension of empirical objects even though change occurs in other dimensions. Piaget partially views concept development in terms of conservation, which is nothing more than stabilization of a particular concept in a child's thinking (Zimmerman, 1971, pp. 16–17). More on conservation appears in Chapter 10.

empirical knowledge of music teachers who "know" that instruction can improve rhythmic behaviors. The next section examines research literature regarding development of rhythmic behavior through learning experiences.

Experimental Research

Most research discussed herein is "experimental" because it seeks to examine the effects of some learning experience on the development of rhythmic behaviors. Much of it, however, lacks the rigorous control necessary to meet Campbell and Stanley's (1963) traditional standards for research design in the behavioral sciences, so interpretations require caution.

The scope and variety of experimental research regarding the development of rhythmic behaviors also make it difficult to reach definitive conclusions. While some studies address behaviors requiring discrimination among rhythmic stimuli, many others involve complex motor behaviors. Some investigators study the development of rhythmic behaviors in young children; others are concerned with older children, adolescents, or adults. The studies cited here reflect the nature and variety of studies on rhythmic learning conducted over the years. Some demonstrated effective experimental treatments; others did not.

Jersild and Bienstock (1935) studied the effects of practice on young children's abilities to keep time with music. Fourteen children, ranging in age from 25 to 44 months, participated in a 10-week training program employing varied means to direct attention to keeping time, including body movements, vocalizations, and hand clapping. Although the 14 children outscored a matched control group, the difference was not statistically significant, and their pretest-posttest improvement also lacked significance.

However, Coffman (1949) showed that a training program involving varied rhythmic activities, including eurhythmics, significantly increased junior high and college students' scores on the Seashore rhythm discrimination test, while control subjects' scores did not increase.

Dittemore (1970) examined the effects of a one-week rote teaching program of chanting and clapping melodic rhythm patterns on first through sixth graders' abilities to chant melodic rhythm patterns. Dittemore observed significant differences among the grade levels for the two criterion exercises involving more complex patterns, but not for the two simpler criterion patterns. The study's nature makes drawing definitive conclusions about training effects or grade level differences difficult.

DeYarmin (1972) compared the effects of training in singing songs in usual, mixed, and unusual meters with training in singing only usual meter songs on kindergarten and first-grade children's chanting of melodic rhythm patterns. No significant differences occurred, although DeYarmin insisted that

music programs for young children "should" include more mixed and unusual meter songs.

Zimmerman's (1971) belief that Piaget's developmental sequence might apply to development of musical behaviors led to research testing the hypothesis that conservation is a function of developmental level and can not be influenced by training. Research by Foley (1975) and Perney (1976), however, suggests that training may facilitate conservation in certain musical tasks.

Foley investigated improving conservation of (a) tonal patterns under the deformation of rhythm patterns and (b) rhythm patterns under the deformation of tonal patterns. Three randomly designated intact second-grade classes underwent experimental training, including varied musical activities intended to foster development of conservation. Three other classes served as control. The experimental classes made a significantly greater increase in conservation of tonal and rhythm patterns than did the control classes. Foley concluded that training can accelerate improvements in the conservation of tonal and rhythm patterns.

Perney (1976) examined the relation of musical training, verbal ability, and the combination of gender and grade on second and third graders' development of conservation of metric time. Results indicated no differences between performances of children who played musical instruments and those who did not. The second graders' mean performance was higher than that of the third graders, but not significantly so. Perney's most important finding was that the second graders had greater verbal ability than the third graders, and there was a statistically significant correlation between children's verbal ability and their ability to perform the musical tasks. Perney concluded that age alone does not determine performance of musical tasks: Verbal ability is more closely related to performance.

More research clearly is necessary before one can draw definite conclusions regarding whether rhythmic development is a function of age or development, and the extent to which training can enhance it. Certainly, there is ample reason to question the hypothesis that rhythmic development is solely a function of age.

Reading rhythm also is an important musical behavior. The balance of this section discusses research on developing rhythm reading skills.

Comparing approaches to rhythm advocated by Richards (1967) and Gordon (1971), Palmer (1976) assigned fourth-grade children (n = 136) to two Richards experimental classes (n = 48), two Gordon experimental classes (n = 50), or two control classes (n = 38). The children provided data on an investigator-constructed measure of rhythmic performance achievement and the rhythm portions of three standardized music achievement tests. Results showed a statistically significant difference between the control and aggregated experimental classes for rhythm reading achievement. However, no

clear difference existed between the two experimental approaches.

Skornicka (1958) compared two approaches to teaching instrumental music reading to beginners. The experimental approach emphasized time and rhythm by requiring playing quarter notes at the beginning of training (rather than traditional whole notes), tapping the foot to mark the beat, and counting time mentally. The control group used conventional band method books and no bodily movements. The experimental group achieved significantly higher *Watkins-Farnum Performance Scale* scores than the control group.

In another study examining effects of bodily movement, notably foot tapping the beat and clapping the melodic rhythm, on junior high school band students' abilities to sightread rhythms, both in isolation and in context with other notational aspects, Boyle (1968) observed that subjects using movement made significantly ($p < .01$) greater increases in both rhythm reading scores and music reading scores than did subjects not employing such movements while reading rhythms. Results were based on individual performance tests given to 191 subjects representing a proportional random sample of the students in 24 junior high training bands. The *Watkins-Farnum Performance Scale* was the measure of music reading ability; its rhythm patterns, notated on a single pitch, served as the measure of rhythm reading ability. Subjects' scores on the two measures correlated strongly ($r = .81$).

Elliott's (1982) multiple regression analysis of factors influencing university music students' instrumental sightreading supports the contention that rhythm reading is an important component of general music reading. Of six predictor variables (technical proficiency, rhythm reading ability, sightreading ability, cumulative grade-point average, grade-point average, and major instrument grade-point average), Elliott concluded that "rhythm-reading ability is the single best predictor of instrumentalists' sight-reading scores" (p. 13).

Researchers also have employed principles of programmed instruction as the experimental variable in teaching rhythm reading. Feedback concerning one's performance is an especially important aspect. Ihrke (1969) found that college students who used a rhythm monitoring device that informed them of improperly timed responses made significantly greater gains on a rhythm reading test than students who did not use the device. Shrader (1970) developed a stereotape teaching machine, where one channel activated a counter to indicate the number of correct responses on a given exercise. He demonstrated that students using the machine made significantly greater gains in rhythmic reading as compared with control students.[14] Shrader's machine

[14]Programmed instruction, where the course designer analyzes course content in a carefully sequenced detailed instructional presentation with ample opportunities for responding and obtaining feedback, was a major educational force (some would say fad) in the 1960s and early 1970s. Many programs clearly "worked;" learners demonstrated improved knowledge and skill after completing programs. However, one must be a bit skeptical of studies comparing programmed instruction to "control" groups because students who study or practice something in detail–by whatever approach–usually learn more than students who do not.

became an accepted teaching tool and remains available commercially (TAP MASTER RHYTHMIC SIGHT READING SYSTEM).

The studies cited above represent the diversity of experimental research related to teaching and learning rhythmic concepts and behaviors. As should be apparent, they reflect diverse purposes, hypotheses, samples, independent and dependent variables, and some contradictory results. As Sink (1983) contends, teaching and learning rhythmic concepts and behaviors are complex and controversial tasks, and the need continues for well-defined systematic research on teaching and learning rhythmic concepts and behaviors. The following examination of teaching practices for rhythmic development further reflects the diversity of opinion and approach.

Teaching Practices for Rhythmic Development

Practitioners' views regarding ways to develop rhythmic behaviors often evolve from trial and error techniques. "Successful" approaches pass from teacher to student to "grandstudent," and many now have become tradition. Most appear to work for their proponents, although, as Horner (1965, pp. 140–141) noted and as the above review suggests, experimental evidence to provide a strong basis for methodological comparisons is rare. Nevertheless, they are included here to provide the reader with an overview of traditional teaching practices for rhythmic development.

Jackson (1963) summarizes devices and techniques commonly used in rhythm instruction. The techniques, all of which remain in use two score years later, include (a) counting aloud, (b) tapping the underlying beat, (c) the metronome, (d) tapping or clapping the phrase rhythm, (e) use of words, (f) ensemble experience, and (g) conducting.

The advantage of counting aloud is that it clearly outlines the beat, but its danger, she contends, is that it emphasizes the beat's mathematical rather than rhythmic aspects. (Also, wind instrumentalists and singers can not count aloud while performing.) Tapping the underlying beat has two advantages over counting: It involves more extensive muscular action and does not emphasize arithmetic. The metronome also focuses on the beat and is valuable for setting a tempo and preventing tempo vacillation, but because it is entirely external and mechanical, its usefulness is limited.

Conducting also helps make students aware of the underlying beat. Kelly (1993) found that beginning band students who received 10 weeks of instruction in basic conducting technique as part of their regular band classes made significantly greater improvements in reading rhythms than did students in control bands who rehearsed more but received no conducting instruction.

Ensemble experience is another method for making students conform to the underlying beat. However, Revelli (1955) maintains that ensemble experience has been a staff for students to lean upon, and that their ability to read suffers from the lack of systematic procedures for analyzing various rhythm patterns.

Tapping or clapping the phrase rhythm and using words as a system of mnemonics may be helpful in learning phrase rhythms.

Muscular movement is basic to most of the rhythm teaching approaches mentioned above. That bodily movement is the best approach to rhythm indeed has become a byword of elementary school music programs, and few references to elementary school music fail to support this view.

Jaques-Dalcroze (1921) was one of the first to explore the possibilities of bodily movement as an aid in developing a sense of rhythm. In his system, generally referred to as Dalcroze Eurhythmics, students learn specific movements for different rhythm patterns. After learning the movements, the students "realize," i.e., express by body movements, the music's rhythms. Much stress is placed upon the ability to improvise rhythmic movements to music.

An especially pertinent aspect of the Jaques-Dalcroze (1915, p. 33) method is the use of separate body limbs to mark the underlying beat and the phrase rhythms. Coordinated movements to music constitute the essence of the system.

The use of rhythm syllables receives continuing attention, perhaps because of the emphasis on applications and adaptations of the Kodály approach (Bachman, 1969; Lewis, 1972; Richards, 1967). Each of these approaches makes extensive use of rhythm syllables in developing elementary aged children's rhythm reading skills.

Gordon (1971, 2000) also advocates rhythm syllables in developing rhythm readiness as a prerequisite to rhythm reading, but he also recognizes that development of rhythmic understanding requires feeling rhythm patterns through movement. He provides an excellent overview of systems using rhythm syllables and stresses the importance of using a system based on beat functions rather than time values (Gordon, 2000, pp. 89–104).

In his final publication regarding teaching rhythm, Mursell (1956, pp. 265–278) summarized three essential approaches to developing rhythmic behaviors; they remain valid today. He believed the first and most essential approach to rhythm is by way of bodily movement. Second, he believed that rhythm instruments are extremely valuable because they tend to sharpen rhythmic behavior by requiring more precise, more definite, and more discriminating responses. Finally, he believed that the study of rhythm symbols allows children a new, deeper, more generalized understanding of rhythmic experience. His recommendations should not be taken lightly.

Hood's (1970) publication on teaching rhythm essentially reflects what Mursell advocated. Moving to music, study of rhythm notation, and the use of rhythm instruments are approaches to teaching rhythm.

Instrumental music teachers tend to focus on teaching rhythm reading. Magnell's (1968) summary of systems for reading rhythm at sight essentially parallels Jackson's, with some elaborations. Magnell views foot tapping as basic to counting, chanting, clapping, and conducting, and advocates the "down-up" principle as a means for organizing rhythm patterns in relation to the beat. Another principle he notes is that of the "time unit." The eighth note usually is the time unit maintained throughout the piece being counted. The student must mark the beat with hand movements or the foot and count the number of time units in each note. Many other teachers also advocate foot tapping, e.g., Hoffer (1973, p. 377), Kohut (1973, pp. 19–23), and Pizer (1969).

In summary, commonalities exist among practitioners' approaches to rhythmic development. Most teachers advocate more than one approach. The relative merits of the respective approaches, however, have not all been verified under controlled conditions. Perhaps, as Palmer (1976) notes, the most important issue is that teachers at least employ some systematic approach to rhythmic development rather than leaving it to incidental learning within the total music curriculum.

Evaluation of Rhythmic Behaviors

Evaluation of rhythmic behaviors generally involves one of three observable behaviors: (a) discriminating between aural stimuli, (b) showing through movement the ability to keep time with a beat or reproduce an aurally presented rhythm pattern, and (c) discriminating between or associating visual rhythm symbols with aurally presented patterns. The last category includes all music reading behaviors, although one could argue that reproducing rhythm patterns from notation constitutes a fourth behavior. In addition, several rhythm tests require behaviors that at best relate only peripherally to the three basic types of behaviors. This discussion is limited, however, to some rhythm tests employing aspects of the three basic behaviors.

Several issues are involved in evaluation of rhythmic behaviors. One noted previously was whether *re*production of patterns or steady beats legitimately indicates rhythmic perception, but it appears that many researchers are content to accept synchronized tapping as evidence of perception. While failure to synchronize tapping with the beat or to reproduce or perform a pattern does not necessarily indicate failure to perceive the pattern, it should raise questions. Motor and perceptual rhythmic behaviors clearly are related.

In selecting or developing a test of rhythm perception or ability, the primary concern is to select a response modality that best demonstrates what one is concerned with measuring. Pilot testing always should be done to

ascertain a test's validity and reliability, as well as its appropriateness for the group being tested. If the concern is for measuring discrimination, the response mode should not require movements that may introduce problems for some respondents. If the concern is for aural-visual discrimination, musical performance should not be involved, but if the concern is for reading music, performance most likely will be involved.[15]

Andrews and Deihl (1967) found that several response modes might be necessary for gaining a clear understanding of children's musical abilities. Their *Battery of Musical Concept Measures,* which unfortunately never became generally available, employed two written group measures (verbal and listening) and two nonwritten individual measures (manipulative and overt).

Rainbow (1981) noted that investigators traditionally make inferences regarding young children's rhythmic perceptions on the basis of movements, e.g., tapping, clapping, or marching. However, data from his three-year longitudinal study suggest that vocal chanting is a much better response mode; his three- and four-year-old subjects had considerably less difficulty chanting than in reproducing patterns through movement. Schleuter and Schleuter (1985) made similar observations for kindergarten and first-grade children's rhythmic responses, and Grieshaber's (1987) review of literature on children's musical tapping yielded similar information.

The question of group versus individual measurement is of practical significance to both researchers and music teachers. While individual testing may be desirable, it often is prohibitive in terms of time and cost. Group measures often must serve as a compromise, although certain performance situations necessarily can not be so assessed.

Whether to evaluate rhythmic behaviors in isolation or within a total music context has been a longstanding concern of music psychologists. Seashore's (1938) view, a "theory of specifics," was that testing should isolate given traits or abilities for evaluation under highly controlled conditions. Mursell's (1937) view, an "omnibus" approach, reflected the belief that musical behavior should be evaluated as a totality, not as subparts. Most contemporary approaches to evaluating rhythmic behaviors attempt to incorporate at least some rhythmic behavior within a total musical context, although many measures also include some breakdown of rhythmic behaviors. Older tests usually reflect one or more approaches, depending on the test's purpose. The purpose of the evaluation and the nature of the data sought ultimately should determine the nature of the chosen evaluative approach.

Several particularly interesting approaches to evaluating rhythmic behav-

[15]In addition to the technical concerns of reliability and validity, the test developer or administrator must consider the need for various adaptations for special needs individuals, such as young children, the visually impaired, persons with cerebral palsy, and the learning-disabled. For a brief discussion, please see Boyle and Radocy (1987, pp. 249–255).

iors have arisen from technological developments, including computer analysis of performance, e.g., Shrader (1970), Petzold (1966), Ihrke (1969), Thackray (1968), and Bengtsson and Gabrielsson (1980, 1983). Such technological advances have greatly facilitated precise analysis of rhythmic behaviors, but, as Grieshaber (1987) noted, such developments pose their own problems. Most computer or other electronic analysis programs lack the flexibility to allow for variability in performance.

A brief overview of some approaches to assessing rhythmic behaviors in published standardized tests follows. Many tests are designed for children over age eight, adolescents, and adults, although two tests are designed primarily for young children.

Test Four of Bentley's (1966a) *Measures of Musical Abilities,* an aural discrimination task designed for children aged seven to eleven, requires subjects to indicate on which of four beats a second rhythm pattern differs from the first. Although normative data are available for Test Four, reliability and validity data are available only for the four tests as a whole.

The *Seashore Measures of Musical Talents*[16] (Seashore, Lewis, & Saetveit, (1939, 1960) include two aural discrimination rhythm tasks. In the "rhythm test," the respondent indicates whether paired tapped patterns are the same or different. The "time test" requires indicating whether the second of paired tones is longer or shorter than the first. Although Mursell and other omnibus theory advocates question the tests' validity as indicators of "musical" talent, they unquestionably are valid measures of the two discrimination tasks, and their reliabilities range from .63 to .72.

The *Drake Musical Aptitude Tests* (Drake, 1957) include a "rhythm test" which really measures the ability to maintain a given tempo silently. Available in two nonequivalent forms, reliabilities range from .83 to .95 for Form A and .69 to .96 for Form B. Validity coefficients, based on comparisons with teachers' ratings of rhythm aptitude, range from .31 to .85.

Gordon's (1965, 1988) *Musical Aptitude Profile* includes a "rhythm imagery" test, which has two subtests. In the tempo test, the respondent must indicate whether the ending of a second presentation of a melody has the same tempo as the first or whether it changed. The meter test asks whether a second statement of a melody is like the first or whether it differs with respect to *accents,* which determine the meter. Split-halves reliabilities for the subtests range from .66 to .85; for the "rhythm imagery" portion as a whole, they range from .82 to .91. Validity coefficients based on teachers' estimates of musical talent range from .64 to .74.

Gordon's *Primary Measures of Music Audiation* (1979), intended for children

[16]As of this writing (2002), the Seashore battery is out of print, despite its long history of use. The battery nevertheless is described here because it exemplifies a particular approach.

in kindergarten through grade three, and *Intermediate Measures of Music Audiation* (1982), intended for children in grades one through four, include a rhythm portion, essentially the same in both batteries, where the child indicates whether the second of two short rhythm patterns is the same as or different from the first pattern. Reliability coefficients range from .60 to .92 for the various grade levels.

The *Iowa Tests of Music Literacy* (Gordon, 1991) include a "Rhythmic Concepts" division, encompassing three subtests. In "Audiation/Listening," the testtaker discriminates between patterns in which beats essentially are subdivided into duplets and triplets. "Audiation/Reading" requires determining whether aural patterns match notated patterns. The "Audiation/Writing" section requires filling in noteheads, flags, and rests to make a notated pattern match an aurally presented pattern. Reliabilities range from about .70 to .80. Gordon maintains that the test has rational and content validity. Concurrent validity coefficients, based on comparisons with sightsinging and dictation scores, range from .44 to .52 for the overall rhythm division. The tests have six levels and provide normative data for grades four through twelve.

Colwell's (1969–1970) *Music Achievement Tests* provide measures of rhythm behaviors in a musical context. A "meter discrimination" subtest asks respondents to indicate whether a musical example moves in twos or threes, i.e., is in duple or triple meter. An "auditory-visual discrimination" subtest asks respondents to indicate measures where the notated melodic rhythm differs from the aural presentation. Reported reliability for the rhythm items is .80. The tests claim content validity because they reflect the objectives common to most basal music series at the time of their construction.

Several measures of aural-visual discrimination also include rhythm as part of a total test, but most do not include separate scores for the rhythmic portions, e.g., Knuth (1966) and Farnum (1953). Rhythm also is one of the scoring criteria for the *Watkins-Farnum Performance Scale* (Watkins & Farnum 1954), but it also provides no rhythm score.

Researchers and teachers concerned with selecting or developing meas ures of rhythmic behaviors should first and foremost consider the nature o the rhythmic task they wish to evaluate and be certain that any measur selected or developed indeed measures that task in a manner appropriate fo the level of student being evaluated.

Summary

The major points of this chapter include the following:

1. Rhythm gives music structure and serves as its dynamic, energizin force.

2. Rhythm structure in music has several basic aspects: (a) tempo, (b) beat, (c) meter, and (d) melodic or phrase rhythm.
3. Initial development of rhythmic behaviors is inextricably related to movement.
4. Four basic types of traditional theories regarding human response to rhythm are instinctive, physiological, motor, and learning.
5. Cognitive perspectives on rhythmic behavior may be categorized as they relate to (a) beat and tempo perception, (b) meter perception, (c) rhythmic grouping, and (d) expressive timing.
6. Response to the beat is considered basic and fundamental, whereas response to metric organization is considered hierarchical; metric organization at levels above the beat are considered future-oriented and at subdivisions of the beat analytical.
7. Perception of rhythm patterns is categorical.
8. Just as metric organization, grouping of rhythm patterns takes place at a basic level (basic segmentation) and hierarchically (hierarchical segmentation organization).
9. Musical experience and training have little influence on basic metric organization and basic segmentation organization, but they have considerable influence on higher level metric and segmentation organization.
10. Expressive timing is an important aspect of expressive musical performance.
11. Although developmental research is inconclusive, rhythmic behaviors generally increase with age for younger children but level out for older children.
12. Training can expedite the development of rhythmic behaviors.
13. Although development of rhythm reading skills is a major concern to researchers and teachers, neither research nor practice yields consensus regarding a "best" way to facilitate rhythm reading.
14. The evaluation of rhythmic behaviors usually involves assessment of one of three basic behaviors: (a) discrimination between aurally presented stimuli, (b) demonstrating ability to keep time with the beat or reproducing an aurally presented pattern through movement, and (c) associating visual rhythm symbols with aurally presented patterns.

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Chapter 6

MELODIC AND HARMONIC FOUNDATIONS

Music's pitch structure has interested people since the beginning of recorded history, and Weber (1958) maintains that the drive to rationalize pitch structure shaped Western musical development to a large degree. Western music's pitch structure has both horizontal and vertical dimensions. While other musics have evolved with elaborate developments of the horizontal dimension, none has approached the sophistication of Western music's vertical dimension, harmony.

The horizontal dimension encompasses pitch sequences. The vertical dimension involves simultaneous pitch structures. Music theorists have codified and explained practices regarding these structures. Systems of scales and harmony are outgrowths of theorists' efforts, although musical practice often precedes music theory.

Music is a social and therefore continually changing phenomenon; consequently, theorists' work is never complete. Scales and harmonic systems based on eighteenth- and nineteenth-century melodic and harmonic practices are inadequate for explaining all twentieth-century pitch structures; they may be even less adequate for twenty-first century music.

Theorists traditionally have focused on melodic and harmonic structures per se, but in recent years they have become increasingly interested in understanding how people perceive and cognitively process and organize melodic and harmonic structures and larger musical forms. Much of the research base for this "cognitive science" approach lies in psychology, linguistics, neurophysiology, philosophy, computer science, and music theory (Lerdahl & Jackendoff, 1983, p. 332). The concern for understanding music perception and cognition stimulated theoretical and empirical research regarding the nature of the cognitive processes or structures involved in interactions with musical stimuli.

This chapter examines the nature of melody and harmony in Western music in terms of both its tonal structure and people's interactions with and response to tonal structure. For convenience, the discussion is organized under several broad headings: (a) definitions of melody, harmony, and tonality; (b) scale, modal, and other pitch structures; (c) cognitive processes underlying pitch-related behaviors; (d) development of melodic and harmonic

behaviors; and (e) evaluating melodic and harmonic behaviors.

Extended Definitions

For most listeners to Western music, melody is inseparable from harmony and rhythm, but people tend to remember melodies more so than rhythms or harmonies. The overwhelming majority of common melodies exist in tonal harmonic frameworks, utilizing chord structures built in thirds and progressing toward somewhat predictable "resolutions."

Melody

Whether constructed within a tonal harmonic framework or not, two factors contribute to each melody's individuality: intertonal *pitch relationships* and *durational relationships*. As noted in Chapter 4, pitch is a relative phenomenon concerning the placement of tones on a high-low continuum. Pitch's circularity, similarity, or intimacy dimension, involving tonal relationships, also is crucial to melody.

Constructing a melody requires selecting tones from the pitch continuum and placing them in temporal sequence. Frequency, the physical basis for pitch, is a continuous variable; any number of Hertz within the hearing range is possible. While not every tiny frequency change will produce a change in apparent pitch, a vast array of pitch sensations is possible, and any pitch conceivably can occur in a melody. *Portamenti* and *glissandi* are examples of melodies using minute and quickly changing pitch differences. Electronic music frequently uses these "sliding" pitches, but most melodies, Western and non-Western, use fixed pitches.

Sloboda (1985, pp. 24–28) suggests that the use of fixed pitches in music may be related to the "categorical nature of pitch perception."[1] He draws some analogies between linguistic and musical structures, noting that basic speech-sound classes of language (*phonemes*), which reflect a *range* of sounds along a continuum, actually are perceived as given sound units. Similarly, he views the use of fixed pitches in music as a "phonology" of pitch, and notes that pitches are perceived categorically, particularly by musicians. In Western music, we are accustomed to hearing musical tones within given scale and tonal harmonic frameworks. Individual tones may be mistuned yet still perceived as a certain pitch. Individual listeners apparently have varying

[1]According to Burns and Ward (1982, pp. 250-251), a speech-perception group coined the term *categorical perception* about 1970 to describe experimental results in which the perception of some speech tokens varied along a single acoustic continuum. Burns and Ward cite various studies demonstrating that the concept of categorical pitch is also appropriate for nonspeech stimuli, especially musical intervals. With musical stimuli, the effect is demonstrated more easily with musically trained individuals who readily are able to label stimuli than with nonmusicians (p. 252).

"categorical boundaries." As long as the boundaries are not exceeded, the listener perceives a tone as having the pitch of that category.

The conventions and traditions of a particular musical culture usually determine the particular fixed pitches used in melodies. In melodies of non-Western cultures, the musics of which often are not based on a tertian harmonic framework, the octave is divided in various ways. Some cultures use *microtonic* scales, dividing the octave into more pitches than the seven Western diatonic scale tones. Others use fewer than seven pitches per octave; their scales are *macrotonic* scales. Most Western melodies utilize tones within the diatonic scale system and have an implied, if not always accompanying, harmonic framework.[2] Regardless of the scale system used in selecting melodic pitches or whether the melody uses sliding or fixed pitches, the sequence of pitch relationships contributes to a given melody's individuality.

As long as a tonal sequence's relative pitch positions and rhythm remain constant, the melody remains the same. Levitin (1999, p. 214) notes eight melodic attributes: pitch, rhythm, tempo, contour, timbre, loudness, spatial location, and environmental reverberation. One may transform a melody in all of the attributes and maintain its identity except for contour, which of course changes pitch positions, and rhythm, provided durational relationships change sufficiently. Consider the song "America" ("God Save the Queen"). One could perform it at a higher or lower pitch level, take it faster or slower (within limits), play it on different instruments, make it louder or softer, perform it in a different part of the room, and/or perform it in a more or less reverberant space, and it will remain "America." However, changing either the relative pitch positions or the rhythm changes the melody *structurally* and may or may not change it *perceptually*. The melody notated in Figure 6-1 has the pitch relationships of "America" ("God Save the Queen"), but the changed rhythm makes it an entirely different melody.

Composers and some performers change melodic tones for aesthetic or artistic purposes. The degree to which a melody's tonal or rhythmic structure can change while still eliciting a response of "sameness" naturally is subject to many variables. Farnsworth (1969, p. 49) believes that once a person learns a melody, he or she can recognize it through considerable changes. However, the degree to which it can be changed and still recognized is a function of the listener's familiarity with the melody, particularly any developed *expectations* regarding it. Dowling's (1973) comparisons of listeners' responses to simultaneous pairs of "interleaved" melodies supports the contention regarding expectations. When subjects knew which tunes to listen for, they were able to recognize them, but when they had no such expecta-

[2]Twelve-tone, or serial, melodies are a notable exception. Such melodies essentially involve the twelve chromatic scale tones sequenced in any order the composer chooses; each tone must be used before repeating another.

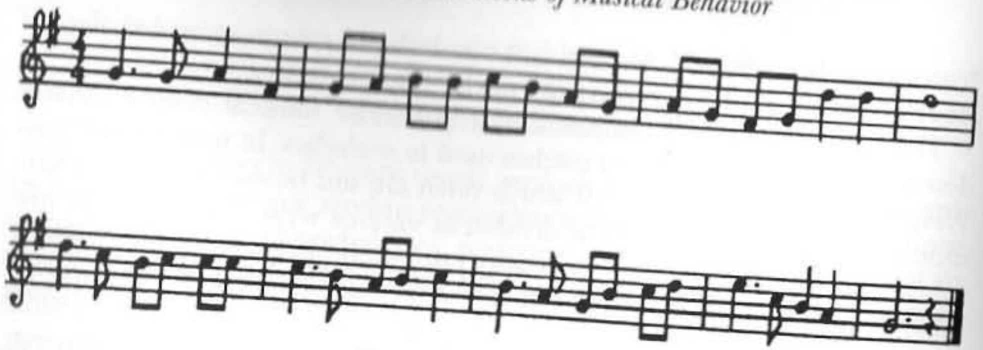

Figure 6-1. "America."

tions, recognition was impossible.

Melody may be defined either in terms of its structural characteristics or people's responses to it. Music theorists traditionally have examined melodies in terms of structural characteristics, while psychologists have been more interested in people's responses to or perceptions of melody. Melody also has been examined from a philosophical perspective, and some definitions of melody allude to the importance of the "aesthetic musical whole" as an essential attribute for making a sequence of single tones viable as melody (Aiello, 1994, p. 173). The present discussion is divided into two broad sections: structure of melody and perceptual organization of melody. Farnsworth (1969, p. 48) classifies descriptions of melody in terms of structural characteristics as *formalistic* and those involving perceptual or psychological variables as *relativistic.*

STRUCTURAL CHARACTERISTICS OF MELODY. In its broadest sense, melody means any succession of single tones (Ortmann, 1926), and, as noted above, both pitch and durational relationships contribute to each melody's individuality. The particular pattern of ascending and descending pitches in a melody's sequence of tones provides *melodic contour.* The uniqueness of a melodic contour is strengthened by its particular rhythmic configuration. As illustrated in Figure 6-1, a radical change in rhythmic configuration may change a melodic contour perceptually. Thus, a melodic contour, together with its unique rhythmic configuration, serves as a *Gestalt* or holistic pattern to which a listener responds. A melody may be performed at different tempi and at different pitch levels, but unless the tempo changes radically, there is a "sameness" about it, and people tend to perceive it as the same melody. More will be said later about variables affecting melodic recognition.

Most discussions of melody's structural characteristics primarily focus on ts pitch attributes. Lundin (1967, pp. 77–79), for example, sees three particlar melodic attributes: *propinquity, repetition,* and *finality.* Most tones of most Vestern melodies are relatively propinquous, that is, close together. Analyses

of melodic intervals by Ortmann (1937) and Radocy (1977) reveal a preponderance of smaller successive intervals (conjunct) over larger intervals (disjunct).

Recently, Von Hippel (2000) suggested further qualifications regarding pitch proximity, which determines propinquity. Two constraints–*tessitura* and *mobility*–make proximity a matter of context as well as of successive interval size. Melodies have particular frequency ranges and overall levels (tessiturae). Intervals tend to "retreat" from tessitura extremes; larger intervals are more likely at extremes. Melodic peaks tend to be approached by skips; skips are likely to be followed by changes in direction. Mobility means that pitches tend to be close to the previous pitch. Heights of consecutive melodic pitches tend to correlate.

Melodies are repetitious in that certain tones tend to repeat with considerable frequency. Radocy's examination of randomly selected melodies from *The Norton Scores* (Kamien, 1972) and from *357 Songs We Love to Sing* (1938) supports Lundin's view. In the Norton example, the tones *do, mi,* and *so* accounted for 45 percent of all the tones; adding *ti* and *re* increased the percentage to 69. The corresponding songbook percentages were 67 and 81. Clearly most Western melodies tend to return to certain tones with great frequency.

Lundin's third attribute, finality, refers to a tendency for melodies to end according to certain conventions of *cadence,* which convey an impression of momentary or permanent conclusion. Cadences in melodies constructed within a Western tonal harmonic framework often have an implied harmonic accompaniment, although not necessarily. Final tones often are ones that have been repeated frequently or emphasized in the melodic sequence.

Ortmann (1926) believed that a melody's structural characteristics could be understood best by examining the pitch relationships of the melodic contour in isolation from harmony and rhythm. His analysis revealed several *static* (his term) attributes of melody that are inherent in all melodies and that tend to attract a listener's attention. They include (a) *first and last tones,* (b) *highest and lowest tones,* (c) *repeated tones,* (d) *interval size,* (e) *pitch direction,* (f) *pitch proximity,* (g) *emphasis in tone groups,* (h) *interval relationship,* and (i) *degree of emphasis.* The first three attributes are termed *absolute,* while the others are considered *relative.* Ortmann maintains that the relative attributes are more important than the absolute attributes. Melodic memory, which involves *relative pitch* recall, is common among listeners to Western music, while *tone memory,* i.e., absolute pitch, is relatively rare.

As may be apparent, the above discussion does little to limit the type of tone sequences that one may call melody. It does, however, reveal that Western tonal melodies frequently use small intervals between tones, repeat some tones with great frequency, and incorporate some type of convention

to establish finality. (A more or less random tonal sequence, as one might obtain by throwing darts at mounted staff paper, is atypical of tonal melodies.) Further, it suggests that the emphasis a tone receives within a melody depends on its structural relationship to other tones within the melody.

Thus, the answer to "What constitutes a melody?" is not solely a function of structural characteristics; the answer also must be considered in terms of the listener.

PERCEPTUAL ORGANIZATION OF MELODY. Mursell's (1937, p. 104) answer to the question "What constitutes a melody?" is that *"a sequence of tones constitutes a melody when it is apprehended in terms of a unified and single response."* But another important question arises: "What psychological factors influence an individual's perception and apprehension of a tonal sequence as a melody?"

A traditional (and still generally accepted) explanation of melodic perception invokes the "laws" of Gestalt psychology. One perceives a melody as a Gestalt in accordance with fundamental organizational principles ("laws") derived from the study of visual perception, the laws of *proximity, similarity, common direction,* and *simplicity* (Bower & Hilgard, 1981, pp. 302–310). Several writers provide excellent reviews of the applications of Gestalt perceptual laws to melodic perception (e.g., Lipscomb, 1996, pp. 145–150; Terhardt, 1987, pp. 157–166). Essentially, the Gestalt perceptual laws as applied to melodic perception suggest that people are likely to (a) perceive tones close together in time and auditory space as a melodic unit, (b) perceive similar (repeated) tones as a unit, (c) hear a melodic sequence as moving in a common direction toward completion, and (d) organize the Gestalt (tonal contour or pattern) in its simplest form.

The structural characteristics discussed above reflect the Gestalt organizational laws. People tend to perceive a tonal sequence as a melody more readily if most tones are close in frequency, involve a certain amount of repetition, and proceed toward a finish in a somewhat direct manner. Relations among the tonal elements themselves define the Gestalt-like experience of melody (Espinoza-Varas & Watson, 1989).

The authors, however, do not intend to suggest, as do some proponents of Gestalt psychology, that capacity to perceive contour or pattern in melody is inborn and requires no learning. As Hebb (1949, pp. 17–59) both argues and carefully documents, the perception of *relative* phenomena, of which melody is one, involves the ability to perceive patterns and develops only as a result of prolonged experience (learning), whether formal or informal, with the particular phenomenon. To recognize a given tonal sequence as a melody requires experience with tonal sequences of a similar style.

Thus, familiarity with a melody or melodic style is an important variable in influencing what an individual perceives as melody. As an individual

interacts with music of his or her culture, he or she learns and comes to accept its melodic conventions. Experience with melodies in a given scale system enables an individual to develop certain *expectations.* When an individual encounters a new stylistically similar tonal sequence, he or she recognizes the new sequence as conforming or not conforming to expectations for that which he or she has learned as melody.

More recent accounts of melodic perception have examined it in terms of cognitive processes and structures.[3] Indeed, the burgeoning research literature in "cognitive psychology of music," as research in the field is termed, focuses primarily on the perception of pitch and melody.

Dowling and Harwood (1986, pp. 124–144) describe a listener's pattern of expectations regarding a melody as a *melodic schema.* (*Schemata* are "knowledge structures," developed from prior experience, with which an observer may organize perceptions into cognitions.) One develops such schemata through immersion in one's musical culture from early childhood. Employing context-dependent information beyond the specific pitches, melodic schemata apparently reflect melodic contour, interval relationships, pitch chroma (pitch's circular dimension), and tonality. Carterette and Kendall (1989, p. 147) view "unconscious" schemata as implicit musical knowledge that guides musical expectancies.

Music psychologists find a theoretical base in Chomsky's (1957, 1965, 1968) seminal work regarding deep structures of language and Schenker's (1935/1979) theoretical system for conceiving surface musical structures as outgrowths of an underlying musical core or *Urtext.* Drawing analogies between hierarchical structures underlying music and language behaviors, music psychologists suggest that music's surface structures (tones and rests) are subsumable into larger and more abstract "deep" hierarchical structures, based on combinations of melodic, harmonic, rhythmic, and extramusical information. Carterette and Kendall (1999, pp. 780–781) contend that while the world's musics differ greatly due to the interaction of geographical, social, and cultural aspects with physiological and psychoacoustical processes, at the level of "deep" structure, organizational principles applied to the world's musics are identical. Sloboda's (1985) excellent text is both an introduction to and a detailed treatment of music's cognitive organization on the basis of abstracted structures.

The "deep" or abstracted structures serve as a means of organization, but their degree of "reality" in any conscious sense is questionable. Cook (1990, pp. 3–4) notes that most people do not actually "hear" large-scale Schenkerian analysis. Even traditional musical forms lack perceptual reality

[3]The reader should remember that *structures* discussed in research in cognitive psychology refer to theoretical cognitive constructs rather then tonal structures *per se.*

for most listeners. Cook (p. 68) suggests that barring training and motivation to track musical form in theoretical terms, listeners experience recurrence of musical ideas and coherence of musical forms without a conscious verbalized explanation. Conscious perception is not a prerequisite for musical enjoyment.

Many attempts to model hierarchical perceptual structuring exist; West, Howell, and Cross (1985) provide an excellent review. (More is said of hierarchical structures later in this chapter.) Examinations of melody's *phonology*, *syntax*, and *grammar* are common to the development of many models. Sloboda (1985, pp. 11–52) provides clear, authoritative definitions and descriptions. Essentially, phonology concerns the way in which pitch sounds (*phonemes*) are divided into discrete sound (perceptual) categories. Syntax is concerned with combining sound units into sequences, and grammar is concerned with the "rules" for using, or processing, syntactical sequences.

Many model tonal hierarchies are built, explicitly or implicitly, upon *generative grammars*, organizational rules that underlie musical structure. This approach is similar to that exemplified by Chomsky's work with language. Sloboda (1985, pp. 34–47) argues that "the *structures* embodied in such grammars have psychological reality" (p. 34). He uses Sundberg and Lindblom's (1976) generative grammar for eight-bar nursery tunes to demonstrate how a musical grammar resembles the generative phonology of language grammars. Lerdahl (1988, p. 233) distinguishes between *compositional* grammars, which generate musical stimuli, and *listening* grammars, which generate mental representations of sonic events. Of particular importance to the present discussion is the fact that many accounts of melodic perception and cognition are couched in terminology reflecting grammatical structures as psychological reality.

Whether one speaks of schemata, rules of generative grammar, or expectations regarding melody, general agreement exists that the Gestalt laws of perceptual organization remain valid. The melodic expectations, or schemata, of an individual growing up in a Western culture most likely are for tonal Gestalts; i.e., they probably are couched in a tonal harmonic framework, utilize diatonic scale tones, generally have small intervals between tones, return with considerable frequency to certain tones, and usually end with some implied conventional cadence.

When an individual confronts a melody in an unfamiliar style, and hence has no particular expectations, the probability of responding to it as a melodic entity is lessened considerably (Meyer, 1967, p. 277). The failure of total serial music to gain widespread acceptance is partly because listeners have not learned the style's structural premises. Meyer also maintains that the nature of serial melodies, which requires that each chromatic tone within the octave appear before another may be repeated, does not allow sufficient repetition or *redundancy* for listeners to perceive them as a melodic whole. The melodic pattern, while structurally *logical*, lacks *psychological* unity for the casual listener. Further, Meyer suggests that no homogeneous stylistic core exists to serve as a reference point for serial music; the stylistic diversity within the idiom is too great. In terms of Lerdahl's (1988, p. 235) generative grammars, the compositional grammar has "lost touch" with the listening grammar.

In essence, a melody appears to be a function of both the structural characteristics of a given tonal sequence and a listener's previous experience with stylistically similar tonal sequences. An individual learns his or her culture's melodic idioms. Some musical knowledge is explicit and verbalizable, but much is implicit, the result of unconscious schemata guiding musical expectations (Carterette & Kendall, 1989, p. 147). Familiarity with cultural melodic idioms provides a basis for developing expectations (or for formulating schemata) regarding unfamiliar tonal sequences, thus enabling response to a new sequence as a melodic entity. However, a culture's melodic idioms are the product of a musical development which recognizes that melodies must incorporate some unifying structural attributes that will enable listeners to perceive and remember them. Tonal sequences that enable perceptual organization in accordance with the Gestalt organizational laws appear to be accepted most readily and therefore most likely to be perceived as melodies. Ultimately, only the perceiver can judge whether a tonal sequence functions as a melody: If it does, it *is* a melody.

Harmony

Harmony is such an important aspect of Western music that people often respond to isolated melodies in terms of harmonic expectations as much as in terms of melodic expectations. As Sloboda (1985, p. 52) notes, "when listeners hear a melody, their processing of it normally involves the attempt to retrieve implicit harmonic and rhythmic structure." Apel (1969, p. 372) maintains that "from the beginning of the eighteenth century on, the beauty of melodic lines depended largely on the effective arrangement of the harmonies underlying them."

In its broadest sense, harmony refers to music's vertical pitch structures as opposed to its horizontal pitch structure, melody. Apel (1969, pp. 371–374) summarizes its development. Early combinations of melodies, *organum*, generally involved parallel motion between two or three melodies, but as judgments developed that certain intervals between melodies "sounded better simultaneously than others, concern grew for the resultant sounds of multiple voices. Not until about the mid-sixteenth century did harmony become a primary structural concern in music. Apel categorizes the era between 90

and 1450 as the period of *pretertian harmony.* (Music prior to this era was essentially melodic.) Harmony of this era is characterized by much parallel motion, open spacing among voices, and some uses of triads at the beginnings and endings of phrases.

The years between 1450 and 1900 are considered the era of *tertian harmony*[4] During this era, Western triadic harmony evolved from triad movement in an essentially modal sequence, through strong tonic, subdominant, and dominant triads in the late baroque and classical periods, to harmonies of the romantic period that exploited the triadic system to its extremes with extensive use of chromatic alterations and distant modulations.

While the preponderance of twentieth-century music was constructed within a tertian harmonic framework, Apel considers the era beginning in 1900 as the period of *posttertian harmony,* primarily because of the development of vertical structures that deliberately violate the triadic harmony system. Debussy's "parallel chords," Scriabin's quartal harmony, Schoenberg's serial techniques, aleatoric music, *musique concrete,* and many of the developments in electronic and avant-garde music reflect efforts to organize the vertical dimension in manners different from tertian harmony. What new developments the twenty-first century will bring to harmonic development remain to be seen.

Because harmony in its various forms is such an integral component of most Western music, and therefore a factor for consideration in examining musical behavior, it will be examined in terms of both its structural and perceptual characteristics.

STRUCTURAL CHARACTERISTICS OF HARMONY. Simultaneous pitch combinations generally are one of two basic textures, *polyphonic* or *homophonic.* (Melody alone is *monophonic,* i.e., it involves only a single pitch at a time.) Polyphonic texture combines two or more simultaneously sounding melodies. Concern with "how good" (the consonance-dissonance character) the resulting simultaneous pitches sound varies to a large degree with the era in which the music was composed. Generally, polyphonic music of the pre- and posttertian eras reflects less concern for the character of the simultaneous sounds than polyphonic music of the tertian harmony era. Homophonic texture features one melody supported by a tertian harmonic framework and considers *both* the resultant horizontal and vertical dimensions of the musical sound.

Most references to harmony in music are to homophonic music constructed in a tertian harmonic framework. Harmony in this narrower and

[4]"Tonal harmonic framework," as used in the previous section, refers to the tertian harmony system. As will be noted in the discussion of tonality, the tertian harmony system elicits a strong feeling for a tonal center; hence, the expression "tonal harmonic framework" applies to music constructed according to the practices of tertian harmony.

more common sense refers to the highly developed system of chords and relations between chords that characterize most Western music, particularly that of the baroque, classical, and romantic periods. While harmonic practices of the three periods differ, there is a common structural base.

Music of these periods, which comprises the predominant styles of "classical" music performed today, is constructed around a key center, also known as the tonal center or tonic. Music constructed around a key center possesses *tonality,* or "loyalty to the tonic." (The next section discusses tonality in more detail.) The triads or chords constructed on the first, fourth, and fifth scale degrees, respectively the tonic, subdominant, and dominant, serve as the primary structural mechanism for maintaining emphasis on the tonal center. Once this mechanism became firmly established as the vehicle for focusing attention on the tonal center, thus providing harmonic unity or repetition, composers could depart from the harmonic framework and then return to the tonic. Harmonic conventions were developed through which functional chord progressions, structured around the tonic, subdominant, and dominant but also extending through chords built on other scale tones as well as through modulations into other keys, served as the primary unifying force. Harmonic practices of the romantic period carried this system to its extremes.

Twentieth-century developments of ways for combining pitches simultaneously have resulted in varied techniques and styles. This is not to suggest, however, that tertian harmony no longer is used as a compositional device. To the contrary, it remains the primary structural mechanism for combining pitches simultaneously, particularly in popular music.

PERCEPTUAL ORGANIZATION OF HARMONY. Theorists have studied and analyzed music's harmonic structure since its inception, and harmony continues to be a major area of study for students preparing for careers in music. Until recently, however, there has been relatively little study of harmony in terms of people's responses to it or their ability to comprehend it.

Traditional attempts to explain response to harmony were mathematical, beginning with the work of the Greek mathematician Pythagoras. Later theorists, including medieval church scholars, also examined and explained responses to the predominantly melodic music of their times in terms of simple mathematical ratios. With the development of music constructed in a tonal harmonic framework, mathematical explanations continued, but because of the compromises of equal temperament,[5] convenient explanations in terms of simple mathematical explanations no longer applied. Consequently, attempts to explain harmony in terms of psychological characteristics must look beyond music's "scientific" or mathematical aspect.

[5]The equal tempered scale is discussed later in this chapter.

Both Farnsworth (1969, pp. 37–41) and Lundin (1967, pp. 88–89) believe that response to harmony is a *cultural phenomenon.* Just as individuals' experiences with their culture's music enable them to develop melodic expectations, the experiences also foster harmonic expectations. Music in which the harmony does not conform in a general way to the harmonic practices with which a listener is familiar sounds "strange" or "different." Even though most listeners can not verbalize *what* sounds strange or different, the effect is disturbing because the listener's general expectations are unfulfilled.

Harmony, just as melody and rhythm, is comprised of patterns and generally is perceived holistically. Individuals respond to harmony as a totality rather than as individual tones or chords. (Only during formal musical training do most individuals attempt to analyze harmony into its constituent parts.)

Individuals respond and develop expectations toward three primary "holistic" attributes of harmonic structure: *tonality, harmonic movement,* and *finality.* The laws of perceptual organization noted under the discussion of melody also appear basic for perceiving harmonic attributes. Tonality, organized around a tonal center or "home tone," provides an underlying reference or redundancy that helps a listener respond to a complex sequential series of multiple sounds bombarding the central nervous system via the auditory sensory mechanisms. As Meyer (1967, pp. 288–293) has noted, experience with music constructed in a tonal harmonic framework provides the basis for perceiving redundancy, in this case tonality, which enables a listener to "make sense" of music heard in relation to expectations.

Response to harmonic movement appears to occur in a manner similar to the response to melodic contour. Harmonic movement or progression is a *relative* phenomenon, as is melody. We respond to harmonic movement in *relation* to tonality. Practices in functional harmony become a standard or model for listeners' harmonic expectations. As harmonic practices change, listeners learn the new harmonic styles and develop expectations accordingly.

Meyer (1967, p. 292) believes that a primary difficulty composers face in having a large number of listeners accept serial music and other music not constructed within a tonal harmonic framework is that such music lacks the unifying harmonic attributes that provide the redundancy necessary for meaningful perception. As Krumhansl (1990, p. 270) indicates, "a basic mismatch may exist between this style's [12-tone serial] treatment of all chromatic scale pitches equally, and the [learned] psychological tendency to relate all pitches to a few stable and unchanging reference pitches." Music constructed in a tonal harmonic framework has an inherent redundancy through its tonal center and harmonic movement in relation to that center.

The direction of the melody line at cadence points is readily predictable

for melodies constructed in relation to a tonal harmonic framework, and eighteenth- and nineteenth-century cadence conventions still provide the basis for most Westerners' finality expectations. Few listeners would not expect a dominant-seventh chord to resolve to a tonic chord, even though most could not label the chords. Experience in hearing harmony provides the basis for such expectations, even without any formal musical training, just as experience in hearing melody builds melodic expectations.

Contemporary music psychologists have not studied harmonic perception to the extent they have studied melodic perception. Articles on aspects of rhythmic and melodic perception abound in edited volumes of research and writings on music psychology (e.g., Aiello & Sloboda, 1994; Clynes, 1982; Deutsch, 1982b, 1999; Howell, Cross, & West, 1985), but they contain relatively little information on harmonic perception. Nevertheless, there is at least a tacit acceptance that, just as for melodic perception, experienced listeners develop internalized cognitive structures or schemata of musical keys, key relationships, and functions of chords within keys. Theory and research to support such assumptions is limited, although some recent research especially related to harmonic perception yields principles suggesting how experienced listeners organize harmonic information.

Krumhansl, Bharucha, and Castellano (1982) identified three *context-dependent* principles of harmonic organization, each of which has experimental support. The principle of *contextual identity* suggests that when a chord occurs in an established key context, it is heard as more closely related to *itself* than when it is out of the key context. This means that listeners will recognize the chord more easily in the context key or a closely related key than in a distant key.

A second principle, *contextual distance,* suggests that two different chords are related more closely (perceptually similar) when they are in the same key than when they are not. The closer the keys, the less extreme the difference.[6] For example, the C and G major triads, which contain tones found in both the C major and G major diatonic scales, are quite closely related. The C major and D major triads, however, are not so closely related, but since D major is the dominant of G major, a key closely related to C major, the C-D relationship is closer than, say, the relationship between the C major and Db major triads.

The third principle, *contextual asymmetry,* relates to the order in which the chords occur in a particular musical example. It suggests that two successive chords are related more closely when the first chord is out of context and the second chord is in context than when the first chord is in and the second

[6]Readers who lack knowledge of basic major and minor scales and principles of triad construction, or of the order of keys as they appear in the circle of fifths, may wish to consult one of numerous music theory texts, or a knowledgeable friend.

chord is out. The strength of contextual asymmetry is a function of the context key and the keys of which the chords could be a part. Perceptual distance decreases as the second chord moves closer to the context key and the first chord moves further from it. As an example, in C major, movement of a D major triad to a G major triad results in a greater perceptual similarity between the two triads than the opposite movement, G to D. If, in the second case, the chords are made parallel *minor* chords so that a G-Bb-D triad moves to a D-F-A triad, the distance decreases.

Krumhansl, Bharucha, and Kessler (1982) identified a "core" of eight chords on the basis of how well the chords from the keys of C major, G major, and A minor seemed to follow each other in paired combinations.[7] The "core" included the I (tonic), II (supertonic), IV (subdominant), V (dominant), and VI (submediant) chords from C major; the I, II, IV, V, and VI chords from G major; and the I, IV, V, and VI chords from A minor. These chords reduce to eight triads: C major (C-E-G), D minor (D-F-A), E minor (E-G-B), F major (F-A-C), G major (G-B-D), A minor (A-C-E), D major (D-F#-A), and E major (E-G#-B). Perceptually, the I, IV, and V chords are particularly close in each key; chords unique to G major or A minor are relatively remote. Subjects perceived C major as the dominant tonality; they had a strong preference for sequences ending on the C chord. There was a lesser preference for sequences ending on the G chord; no regular pattern existed for A minor.

Bharucha and Krumhansl (1983) gathered further evidence that the principles of contextual identity, contextual distance, and contextual asymmetry governed harmonic organization in tonal contexts. On the basis of their experimental data obtained from musically experienced subjects who evaluated how "well" one chord seemed to follow another or how "well" a chordal sequence differed from another due to one altered chord, the investigators reconfirmed the "context" principles and identified three additional "key" principles that govern harmonic organization *independently* of context: *Key membership, intrakey distance,* and *intrakey asymmetry.*

The "key" principles are not surprising in view of the traditions of Western music theory, but the investigators provided a research base. According to the key membership principle, chords from the same key are more related than chords from different keys. For example, the G major and E minor triads, I and VI from G major, are more related than the G major and Eb major triads. The intrakey distance principle says that a key's I, IV, and V chords (the key's "harmonic core") are related more closely than the key's "noncore" chords. In D major, for example, the relationships among the D, G,

[7]C major is closely related to each of the other keys: G is the dominant scale degree of C, and C is the subdominant degree of G. C major and A minor are relative major and minor keys. G major and A minor are less closely related.

and A major triads are stronger than the relationships among the triads built on the remaining scale degrees, E, F#, B, and C#. Intrakey asymmetry means that paired chords from the same key are related more closely if the first chord is not in the "harmonic core" and the second is than they are if the first chord is in the "core" but the second is not. The II-V relationship, exemplified in C major by a D minor chord moving to a G major chord, is closer than the V-II relationship, exemplified in C major by the G-D chordal movement.

Together, the "context" and "key" principles summarize the organization of harmonic information, according to Bharucha and Krumhansl. The "context" and "key" principles reflect how experienced listeners abstract underlying structures from complex musical stimuli. The principles also suggest that harmonic perception involves the perception of *relationships* among patterns, particularly those related to chordal sequences and keys. One also could argue that the principles provide further support that the Gestalt organizational laws operate during music perception; they certainly do not refute them.

Krumhansl (1990, p. 211) points out the "strong interdependencies between the three levels of musical structure: tones, chords, and keys" and notes that empirical studies support the view that "structures applicable to tones, chords, and keys are strongly tied to one another." Further, she notes that the correspondence between psychological data and the frequencies of tones and chords in tonal harmonic music suggests that the "internal representation of tonal and harmonic relations is acquired through experience" (p. 212).

Tonality

Implicit in the discussion of both melody and harmony is recognition that tonality unifies the perception of music constructed within a tonal harmonic framework. Tonality traditionally has been defined as "loyalty to the tonic" or the tonal center of a musical work (Apel, 1969, p. 855). Butler and Brown (1994) characterize tonality in two senses, as *keyness,* which is the result of a system of pitch relationships from which listeners determine a piece to be *in* a key, and, in a broader sense, as an *idiom,* similar to a dialect. They consider baroque, classical, romantic, and much twentieth-century music to be tonal idioms, a common feature of which is that they provide an experienced listener with a "home base, a central and most important pitch" (p. 197).

A special issue of *Music Perception* (Summer 2000) devoted to *tonality induction* suggests that the "fuzzy state" of views regarding tonality's nature has led to various conceptualizations of tonality induction. Citing two authoritative sources (Dahlhaus, 1980; Thomson, 1999), Vos (2000) notes various defini-

tions, including "key finding," "tonal awareness," "tonal center perception," and "tonal feeling" (p. 405). He considers conceptualization and definition but one of the issues in studying tonality induction; others include various dualities involved in studying music and music processing, e.g., tone versus note representations, horizontal (melodic) versus vertical (harmonic) cues, and tonal versus temporal cues. Tonality induction is in its infancy as a field of study, and researchers most likely will address the issues Vos raises in the years ahead.

Regardless of terminology and other issues regarding tonality, general agreement exists that the tonic is the *tonal center* and serves as the tone to which other tones ultimately return. Tonality provides a sense of both pitch level and mode. The tonal center is the basic musical expectation to which most other expectations relative to melodic and harmonic perceptions are related.[8] Such relationships also are an extension of the intimacy, similarity, or circularity dimension of the psychological tonal property of pitch, discussed in Chapter 4.

Implicit in most discussions of tonality in Western music is the application (and limitation) of the term to music constructed in a tonal harmonic framework, using essentially tones of either a major or minor diatonic scale. As noted in the next section, Western tertian harmony is built with the scale and chord tones of diatonic scales, and references to tonal music and tonality usually refer to music constructed of scale and chord tones from diatonic scales.

Much twentieth-century music, however, does not have a tonal harmonic framework; some music is structured specifically to be atonal. Yet Temko's (1972, p. 33) study of pitch predominance in twenty avant-garde compositions revealed agreement among subjects concerning a predominant pitch in each composition. Apparently even atonal and electronic music not designed with an *a priori* tonality may evoke listener responses in terms of some central or focal pitch.

Melodic movement in tonal music includes both conjunct and disjunct motion. Conjunct motion is essentially scalar, although chromatic and/or altered scale tones may be used. Disjunct motion involves skips or leaps, usually on tones outlining chords underlying the implied harmonic framework. Melodies of the baroque and classical periods tend to outline scale and chord patterns more clearly than music of the romantic period, much of which involves chromaticism and frequent key modulations.

Taylor (1976) reports that pitch structure of melodies is one determinant of tonality. The more the melodic movement conforms to the scale and chord structure of the key in which a melody is constructed, the greater the tonal

[8]Bharucha (1994) makes an eloquent case for tonality as a basis for both perceptual and aesthetic expectations.

strength, or tonality, of the melody. Melodies not using the scale and chord tones of the defined key have less tonal strength, and melodic contour alone does not appear to be a significant factor in determining a melody's tonal strength.

Tonal strength may be quantified in terms of ambiguity by using an adaptation of information theory (Attneave, 1959; Taylor, 1971, 1976). Individuals sing what they hear as a melody's tonal center; the proportions of singers singing any particular tone of the twelve chromatic scale tones are placed in the formula,

$$TS = \Sigma p(\log_2 1/p)$$

where

$$TS = \text{tonal strength obtained by consensus,}$$

and

$$p = \text{proportion of observers selecting any particular tone.}$$

If all sing the same tone, there is no ambiguity regarding tonal strength, and the quantified value is 0.00. The upper limit depends on the number of singers; if there were twelve singers and each sang a different chromatic scale tone, the TS would be 3.58.[9]

Cuddy's (1982) research on tonality perception yielded similar results. Her subjects rated melodies ending on the tonic and employing diatonic scale tones in patterns based on tertian harmonic traditions as having stronger tonality than melodies whose structures did not closely follow the diatonic scale and tertian harmony chord patterns. Cuddy's subjects included both trained musicians and people without formal musical training; results were virtually identical for both groups.

Baroque and classical melodies tend to have greater tonal strength than romantic melodies. In turn, romantic melodies elicit a stronger feeling for tonality than melodies not written within a tonal harmonic framework.

A number of researchers (e.g., Boltz, 1999; Butler & Brown, 1994; Dowling, 1994; Hershman, 1995) have recognized rhythm's importance in determining tonality. The placement of basic scale and chord tones on strong and weak beats has considerable influence on listeners' perceptions or feel-

[9]Readers interested in trying the formula should note that the logarithm of each 1/p is a logarithm of base 2, not base 10 (common logarithm). In general, one may express a number N as a logarithm of base *n* via the formula $\log_n N = \log N \div \log n$. For base 2, log *n* (log 2) is 0.30103. The $\log_2$ of, say, 3 is 1.58496 (log 3 = 0.47712; 0.47712 ÷ 0.30103 = 1.58496).

ings of tonal center and a mode.

The "context" principles (Krumhansl, Bharucha, & Castellano, 1982) and the "key" principles (Bharucha & Krumhansl, 1983) suggest that perception of harmonic movement in tonal music also is intertwined with and dependent upon tertian harmony chord patterns. With the development of functional harmony in the seventeenth and eighteenth centuries, the basic patterns of harmonic movement and relationships among chords were established. The consistency of harmonic progressions in eighteenth-century music provides sufficient redundancy for listeners to develop and maintain strong feelings for tonality. Music of the romantic period, which also is constructed essentially within a tonal harmonic framework, extends harmonic practices far beyond those of the baroque and classical periods. The extent to which the "context" and "key" principles, derived under carefully controlled (perhaps "stereotypical") conditions, apply to romantic period harmonic practices is uncertain.

Most examinations of psychological structures and processes related to tonality perception continue to employ Western music constructed within a tonal harmonic framework. However, tonality, broadly speaking, is a psychological structure based on tones functioning as if they are related to a particular tonal center, established through experience. Relationships affirming tonality may occur among tonal relationships in all musical styles. Even "atonal" music may appear to have a tonal center with repeated listening.

Scales and Modes

Definitions of *scale* and *mode* are many and varied. In a narrow sense each has a particular meaning: A scale is an array of tones configured from a particular home tone, such as A or B; a mode is a particular pattern of whole and half steps,[10] such as major, harmonic minor, or Dorian. The A major scale (A-B-C#-D-E-F#-G#-A) is based on A, with the step sequence (whole, whole, half, whole, whole, whole, half) characteristic of major scales. The G harmonic minor scale (G-A-Bb-C-D-Eb-F#-G) is based on G, with the step sequence (whole, half, whole, whole, half, one and one-half, half) characteristic of harmonic minor scales. In a broad sense, scale and mode refer to the same phenomenon: the basic tones of a composition arranged in order of pitch from lowest to highest (or highest to lowest). Most Western music divides the octave into a basic number of discrete fixed pitches, which psychologists now recognize as being perceived as members of *pitch classes* or *categories,* hence the increasing number of references to fixed pitches as *cate-*

[10]Some people prefer "tone" or "whole tone" for "whole step," and "semitone" for "half step." In any case, half steps (semitones) are represented by adjacent keys on a standard piano, regardless of color. Whole steps (tones) skip a key. The authors use the terms interchangeably.

gorical pitch. The number and particular arrangement of pitches in a scale or mode may vary, although convention suggests that only a limited number of pitch arrangements have gained widespread acceptance.

Usage implies acceptance. Particular pitch arrangements that continue in use by at least some culture or subculture apparently have a certain acceptance; pitch arrangements not in use apparently are unacceptable.

Conventional practice in today's Western music divides the octave into twelve equal half steps or semitones, i.e., a *chromatic* scale, which one may produce on virtually all standard musical instruments. (Even though ancient Greek and medieval church scholars recognized chromaticism, dividing the octave into twelve *equal* semitones did not occur until the development of equal temperament, discussed later in this chapter.) While chromaticism is very much evident in romantic and some contemporary music, the chromatic scale never became Western music's predominant scale.

The *diatonic* scale, a designated order of tones and semitones, which preceded the chromatic scale historically, remains the predominant pattern. Essentially, a scale is diatonic if the octave includes seven fixed pitches, arranged in a particular modal pattern of whole and half steps, with an eighth pitch doubling the lowest at the octave and eliciting a response of functional equivalence with the lowest tone.

The phenomenon of the functional equivalence of octaves, sometimes referred to as octave generalization or examined in terms of perceptual similarity, intrigues many persons concerned with understanding music perception. Octave similarity is related to a pitch property called *tone chroma,* an outgrowth of a "two-component theory" of pitch that recognizes two dimensions, *tone height* and *tone chroma* (Revesz, 1953, pp. 59–65). For Western music, generally, tones of different pitches (and usually pitch names), i.e., tones other than at the octave, are said to differ in pitch height; tones at the octave (and usually having the same pitch name and sharing the same "pitch class") are said to have the same tone chroma.

The complex phenomenon of tone chroma often is represented graphically by a helix or torus in which tone chroma is a circular dimension and tone height is a vertical dimension. Additional dimensions may exist in other geometric configurations. Several excellent accounts of the phenomenon are available (Deutsch, 1982a; Sergeant, 1983; Shepard, 1982), and readers interested in examining the perceptual bases of tone chroma may want to consult them. Deutsch (p. 272) notes that contemporary music theorists make an analogous distinction between *pitch* and *pitch class.* Tones at the octave, the functional equivalents, are considered members of the same pitch class.

In common usage, the sequential arrangement of tones and semitones within the octave determines whether the pitch arrangement is considered a scale or mode. The two predominant pitch arrangements for Western tonal

music are the major and minor scales, although many consider those scales to be particular modes, which technically they are. Following is a discussion of scale functions, scale tuning systems, major and minor scales, and other modal and scale structures.

Function of Scales

Scales provide a sense of musical reference, which Shepard (1999, p. 187) feels is due to the asymmetry resulting from unequal division of the octave. Scales also provide a means of reducing the myriad of possible pitches to a manageable number of working pitches; Sethares (1998, pp. 49–50) suggests that categorical perception may be responsible, as may ease of writing and performing music. Carterette and Kendall (1999, p. 780) suggest that division of the octave into scale steps is a possible cross-cultural musical "universal."

While the tendency to have musical scales may be a "universal," particular musical scales are social phenomena that allow people to exploit tonal relationships, as Mursell (1937, p. 107) noted long ago. He maintains that scales are *not* manifestations of some mathematical ideal. Neither, he says, are there natural scales; if there were, all cultures would use the same scale.

People create musical systems. As a system develops, it changes to allow for human feelings and perceptions rather than to fulfill any order of goodness regarding frequency ratios. Evolved scale systems reflect attempts to codify and make the systems available for use by others. If music were not a sociocultural phenomenon, there would be no need for consensual scale systems; each person could develop a private scale system.

The tempered diatonic scale system probably is the world's most far-reaching and authoritative standardization of music for social purposes (Mursell, p. 107). Musical instruments, notation, and practices of Western cultures are bound so integrally to this system that new systems which are incompatible with the diatonic scale system appear unlikely to gain widespread acceptance. Even in electronic music, the compositions that generally meet with greatest acceptance usually involve use of some traditional instruments or timbres and melodies and harmonies based on the diatonic scale.

Musical scales also provide a basis for establishing definite tonal relationships. Together with rhythm they provide the consistency that people need to deal with the infinite range of sounds from which music is comprised. Scales enable people to create and organize from sounds and silences a construct (music) that has aesthetic and functional value for significant proportions of most cultural groups. Without a predominant scale system, music would not likely have become the potent force it is today.

Scale Tuning Systems

Throughout music history, changes have occurred both in the frequency standard, an absolute phenomenon, and the tuning of scales, a relative phenomenon. Backus (1977, pp. 150–151) notes that the frequency of A_4 (second space on the treble clef staff, the present A440) has varied from somewhere between 415 and 428 Hz in the mid-eighteenth century to 461 Hz in the late nineteenth century. It was not until 1953 that the International Standards Organization officially recognized A = 440 Hz as the frequency standard for music.

Mathematicians, acousticians, and music theorists have subjected scale tuning systems to much debate since the time of the ancient Greeks. While the tempered diatonic scale is today's standard for Western music, much controversy continues regarding performance practices with respect to it and other tuning systems (Barbour, 1951, pp. 196–201; Farnsworth, 1969, pp. 26–27; Ostling, 1974).

Tempered means that the scale tones have been changed so that, except for the octave, intervals resulting from simultaneous combinations of tones within the scale are not in simple, i.e., whole number, mathematical ratios among the frequencies of the respective tones, as are some intervals in some other tuning systems. *Equal temperament* is the name given to the tuning system that divides the octave into twelve equal semitones.

Equal temperament developed along with, and indeed helped make possible, the development of Western tonal harmony. Earlier tuning systems were adequate for monophonic music and to a degree for polyphony, but as polyphony developed, with increased emphasis on the sonorities resulting from the music's vertical structure, previous tuning systems proved inadequate. While detailed discussion of the various tuning systems is more appropriately a concern for musical acoustics or history texts, a brief discussion of the most prominent systems is necessary here, particularly since controversy remains regarding tuning used in contemporary performance. Readers interested in studying tuning systems in greater depth should consult the excellent presentations by Barbour (1951), Backus (1977), Blackwood (1985), and Wilkinson (1988). Blackwood provides an authoritative and detailed mathematical basis for the recognizable diatonic scales. Wilkinson provides a basic guide to alternative scales, temperaments, and microtunings using synthesizers, with particular focus on microtonality and microtuning in twentieth-century electronic music. Wilkinson also includes descriptions of several contemporary tunings, including the 19-, 24- (quarter-tone), 31-, and 53-tone scales.

The diatonic scale has its roots in *tetrachords*, the basis of the Greek "Greater Perfect System." Tetrachords were series of four descending tones,

Table 6-1

RATIOS AMONG INTERVALS OF THE PYTHAGOREAN DIATONIC SCALE ON C

Freq. ratios from *do*			9/8		81/64		4/3		3/2		27/16		243/128		2/1
Freq. ratios adjacent tones		9/8		9/8		256/243		9/8		9/8		9/8		256/243	
Frequency*	256		288		324		341.3		384		432		486		512
Pitch name	*do*		*re*		*mi*		*fa*		*so*		*la*		*ti*		*do*

*Scientific pitch, which has middle C = 256 Hz, as opposed to standard pitch, which has middle C = 261.3 Hz, is used for convenience.

the range of which was a perfect fourth. Depending on the arrangement of the two inner tones, the tetrachords were one of three *genera: diatonic* √(two whole tones and one semitone), *chromatic* (a minor third and two semitones), or *enharmonic* (a major third and two quarter tones). The diatonic genus apparently was the most popular among theorists at the time. Combinations of tetrachords, primarily in conjunct arrangement and with an added tone at the bottom, formed the Greek Greater Perfect System, from which the present diatonic system evolved. The pattern *do, re, mi, fa, so, la, ti, do,* although originally conceived in inverse order, has been basic to most Western music ever since.

Tuning of Greek scale intervals apparently was based on the system developed by Pythagoras (*c.* 550 B.C.E.). His tuning system, now called the Pythagorean scale, derived frequencies of all scale tones from the interval of a pure, i.e., beatless, fifth, which has the simple ratio of 3:2 between the respective upper and lower tonal frequencies.[11] Theoretically, the Pythagorean diatonic scale frequencies are obtained by forming a series of successive ascending fifths, which then are lowered to the correct octave to form the scale. In practice, as Backus (1977, pp. 137–139) and Roederer (1995, p. 173) describe, one derives the scale by tuning a beatless ascending fifth, a beatless descending fourth, a beatless ascending fifth, etc. The result is the same, a scale that has beatless perfect fourths, fifths, and octaves (see Table 6-1).

As long as melodic music is performed without transposing, modulating, or using chromatic tones, the Pythagorean scale works well. However, its small semitone is a problem for instrument makers. Further, when the tuning system is extended to include chromatic tones, it results in nonequivalent enharmonic tones, thereby yielding different sizes of semitones. Also, since

[11]The perfect fourth (ratio = 4:3) also may be the basis for deriving a Pythagorean scale.

Table 6-2

RATIOS AMONG INTERVALS IN JUST INTONATION

Freq. ratios from *do*			9/8		5/4		4/3		3/2		5/3		15/8		2/1
Freq. ratios adjacent tones		9/8		10/9		16/15		9/8		10/9		9/8		16/15	
Frequency	256		288		320		341.3		384		416.6		480		512
Pitch name	*do*		*re*		*mi*		*fa*		*so*		*la*		*ti*		*do*

a Pythagorean scale must be formed in relation to a given starting point, identical letter names may have different frequencies in different keys; e.g., F will be slightly different in the keys of C, Eb, and A. Clearly, the Pythagorean scale is inadequate for Western tonal harmony.

Just intonation, according to Barbour (pp. 89, 105), apparently evolved during the fifteenth and sixteenth centuries as theorists sought to improve upon Pythagorean tuning. Just intonation has some advantages over Pythagorean tuning in that it uses more simple ratios between tones and accommodates building triads from simple ratios among major and minor thirds. Just intonation is so named because its intervals conform to the ratios between the tones of the overtone series;[12] i.e., the fifth has a 3:2 ratio, the fourth a 4:3, the major third a 5:4, and the minor third a 6:5. Table 6-2 shows the ratios among adjacent frequencies and in relation to *do.*

Although having the putative advantage of simple ratios, which produce beatless thirds as well as fourths and fifths, just intonation also has a number of disadvantages, which make it practically useless in most Western tonal music: (a) the scale has two different ratios for whole tones (9:8 and 10:9), (b) the fifth between the second and sixth scale degrees (D-A in reference to the key of C) is not the same as other fifths (27:40 versus 2:3), and (c) it does not accommodate modulation to other keys. The farther away from the reference key and the more use of accidentals, the more untenable the system becomes. Just as Pythagorean scales, just scales have tones that require different frequencies in different keys. In short, it is of little value for fixed pitch instruments, which must accommodate chromaticism and modulation or transposition to all keys.

Despite the just scale's impracticality for most music of the last 250 years or so, it does have its advocates. Some claim that instruments of variable

[12]The "overtone," "harmonic," or "partial" series is the sequential order of theoretical components of a complex tone with no missing harmonics. It has considerable practical value in deriving fingerings for wind instruments, especially brass instruments.

pitch (strings, voice, and, to an extent, winds) can (and should) accommodate modulation difficulties by adjustment and hence play thirds "better in tune," i.e., with "purer" or beatless intervals–the "pure" thirds justify (no pun intended) the just scale. Some people interested in metaphysics or numerology find comfort in the "superparticular" intervalic ratios, where the upper ratio symbol is exactly one more than the lower symbol, as in 3:2, 4:3, 5:4, etc. Backus (1977, pp. 144–146) briefly discusses just scale advocacy positions.

As efforts were made to accommodate harmony and modulation in Western music, two other systems evolved: *meantone* and *equal temperament.* Both involved altering or tempering some scale tones. Meantone temperament's initial use is unclear, but Barbour (1951, p. 25) suggests that it was as early as the beginning of the sixteenth century. Several variations of meantone tuning exist, but the system's essential aspect is that it alters (flattens) some of the Pythagorean fifths, thus allowing a limited degree of modulation. Its name was derived from the fact that the whole tone C-D was half the size of the major third resulting from the alterations of the fifth. Meantone temperament was used extensively in Europe throughout the seventeenth century and well into the eighteenth century until the acceptance of equal temperament.

Equal temperament is so named because it divides the octave into equal divisions. Division into twelve equal semitones is by far the most common, although other divisions are possible. Division into n steps requires extracting the nth root of 2, since the octave is a 2:1 ratio.[13] The nth root in relation to 1 then forms the ratio for any pair of adjacent chromatic scale tones; in the case of the conventional twelve-step division, that ratio is 1.05946:1. Although the octave is the only simple ratio (2:1), the other intervals maintain a consistent size, regardless of key or position within a key. Equal temperament overcomes the limitations on transposition, modulation, and use of chromaticism that are inherent with Pythagorean, just, and meantone tunings.

The equal tempered semitone is divided into 100 equal parts called *cents,* measurement units for physical interval size. Any equal tempered semitone is 100 cents, regardless of the actual frequencies comprising the interval. Any whole tone is 200 cents. An equal tempered fifth is 700 cents (it encompasses seven semitones); the octave, containing twelve semitones, is 1200 cents. One may compute cents for a given interval with the formula $n = 3986.31\,[\log (f_2/f_1)]$ in which n = number of cents, f_1 = lower tone frequency, and f_2 = upper tone frequency.

[13]The nth root of any number N may be found by dividing the common logarithm of N by n and finding the antilogarithm of the quotient. For the usual equal tempered scale derivation, $\log 2 = 0.30103$. $0.30103 \div 12 = 0.02506$. Antilog $0.02506 = 1.05946$.

Table 6-3
COMPARISON OF PYTHAGOREAN, JUST, MEANTONE, AND EQUAL TEMPERED TUNINGS

	do	*re*	*mi*	*fa*	*so*	*la*	*ti*	*do*
Pythagorean	0	204	408	498	702	906	1110	1200
Just	0	204	386	498	702	884	1088	1200
Meantone*	0	204	386	503	697	890	1083	1200
Equal	0	200	400	500	700	900	1100	1200

*This is the tuning used by Pietro Aron around 1523.

Cents are a convenient way to compare the size of intervals in various tuning systems. Table 6-3, adapted from Farnsworth (1969, p. 25), compares interval sizes from the four tuning systems discussed above. As is apparent, the equal tempered fifth is slightly (2/100 of a semitone) smaller than the beatless Pythagorean and just fifths; conversely, the equal tempered fourth is slightly larger than the Pythagorean and just fourths.

The major discussions regarding tuning tendencies in contemporary performances center on tuning the major third, *do-mi,* and the size of the interval between the leading tone (*ti*) and *do.* Although equal temperament is recognized as the standard, some performers insist that triads are "better in tune" if they approximate the tuning of the just triad, which has a major third 14 cents smaller than the equal tempered major third. This would be possible for performances of a cappella choirs and string ensembles, which are not bound by the constraints of keyboard or many wind instruments. Some early research (Greene, 1937; Nickerson, 1949) suggests that string players tend to adjust intonation to approximate Pythagorean tuning when performing leading tones. Backus (1977, p. 150) notes that musicians tend to make adjustments in accordance with what "sounds best." What "sounds best" may defy placement in any one scale system. Sethares (1998, pp. 70–74) points out that musicians have a high degree of tolerance for mistunings in the context of musical performance. There is no irrefutable argument for adhering to any one scale system; the kinds of sounds desired determine any scale propriety or deviation.

Barbour (1951, pp. 191–202) and Ostling (1974) review much of the rhetoric regarding the issue and cite limited research. While little research exists regarding choirs' tuning tendencies, Barbour suggests that even if choirs did attempt to adjust to just intonation, the overall pitch probably would fall if the harmonic progressions are traditional diatonic progressions. While he concedes that such adjustments might be possible in modal progressions such as those used by Palestrina, he maintains that choirs singing with wind instru-

ments quickly adapt to the intonation of the accompanying instruments.

Perhaps the classic study of intonation tendencies in performance was by Nickerson (1949), who analyzed performances of individual members of string quartets, both in isolation and in ensemble. He concluded that (a) performances do not conform completely to any tuning system, (b) performances of melodies both in solo and ensemble approach Pythagorean tuning, and (c) factors that cause this pattern appear to dominate both ensemble demands and presumed experience with equal temperament.

Roederer (1995, p. 177), however, cautions against concluding that soloists have a particular preference for Pythagorean intonation. He notes that other studies (e.g., Terhardt & Zick, 1975) have shown performers tending to play or sing the upper tone of all successive intervals sharp.

While research remains inconclusive regarding intonation practices in contemporary performances, and practices vary and evolve continuously, much deviation from equal temperament does occur and is considered "acceptable." Ostling's (1974, p. 18) summary remains relevant:

> Research agrees that good intonation is not any one basic tuning system used exclusively. Beyond that, it seems . . . that a basic minimum standard of at least equal temperament should be expected–the norm–from which artist-performers will depart for melodic gravitation and/or harmonic reinforcement, as the situation requires, and that is about all one can conclude.

Meanwhile, we still have a cappella choir directors who insist that their choirs are able to sing in just intonation. Some string players consistently report that they must adjust their intonation differently when playing in a string quartet and when playing with (an equal tempered) piano accompaniment. The debate likely will persist.

Major and Minor Modes

Major and *minor* are terms used to describe interval size and types of scales, triads, or keys. With intervals the term simply denotes differences in intervals of a second, third, sixth, or seventh; minor intervals in each class contain one less semitone than the corresponding major interval.

When used to distinguish among types of scales, triads, and keys, the basic distinction between major and minor is in the size of the third: The third of the major scale (key, triad) is four semitones, while the third of the minor scale (key, triad) contains only three semitones.

The pattern of tones and semitones within a scale constitutes the mode.[14]

[14]The mode is determined by the interval pattern within the scale, not by the scale tuning system. One may construct a major, minor, or another mode within a just, Pythagorean, tempered, or any other system.

The basic interval pattern of the major scale or mode is TTSTTTS, where T stands for a whole tone and S stands for a semitone. The minor mode has three variations: natural, melodic, and harmonic. All three forms have the lowered third, thus beginning TS for the intervals between the first three tones, but vary in the intervals between the highest three tones. From the lowest tone, the interval patterns for the three forms, respectively, are natural–TSTTSTT, melodic–TSTTTTS (ascending) and TSTTSTT (descending), and harmonic–TSTTSAS, with A standing for an augmented second.

The establishment of major and minor as the tonal bases of Western music appeared to evolve with the establishment of equal temperament and the development of harmony. In equal temperament, major and minor scales may be constructed on each of the tones in the chromatic octave. The interval and chordal relationships within a scale built on any point within the octave, i.e. in a given key, are functionally identical to those built in other keys. The fact that music built on major and minor scales (and their harmonic patterns) has dominated Western music of the past 350 years so completely suggests that major and minor scales and their concomitant systems of tonality and harmony provide an intelligible tonal harmonic framework for most listeners.

Other Modes

While major and minor are the predominant scale modes for Western music, many other scale patterns exist, both within Western culture and in other cultures. No other pattern, however, has developed into a harmonic system that in any way approaches that of Western tonal harmony based on the major and minor scales, although some scales are in many respects compatible with Western tonal harmony.

The traditional narrow sense of the term *mode* refers to the *church modes* devised by medieval church scholars. They consist of eight diatonic scales using the names of earlier Greek modes but differing in organization and structure, which provide the tonal basis of Gregorian chant. As Apel (1969, p. 165) indicates, the church modes may be illustrated via a keyboard by using the white keys, starting on D, E, F, or G, and playing up the octave. For each starting note (final or *finalis*), two modes, differing in their octave range (*ambitus*), exist. For *authentic modes,* the ambitus goes from the final to the upper octave. For *plagal modes,* the ambitus runs from a fourth below the final to a fifth above.

In the sixteenth century additional modes, equivalent to the natural minor and major modes, were added to the modal system. The four traditional authentic church modes are the Dorian, Phrygian, Lydian, and Mixolydian. The plagal modes use the same names but include the prefix "hypo." The

added natural minor mode is Aeolian; the added major mode is Ionian. Some recognize a Locrian mode, although the Locrian and Hypolocrian modes are suspicious because they require a diminished fifth above the final. What makes a mode a particular mode is its characteristic intervalic structure. The following lists the various modes, indicates the ascending interval sequence (T = whole tone, S = semitone), and gives letter names for the "white key" final and range; the reader should realize that any mode may start on any letter name.

Mode	*Interval Sequence*	*"White Key" Final*	*"White Key" Range*
Dorian	TSTTTST	D	D-D
Hypodorian	TSTTSTT	D	A-A
Phrygian	STTTSTT	E	E-E
Hypophrygian	STTSTTT	E	B-B
Lydian	TTTSTTS	F	F-F
Hypolydian	TTSTTTS	F	C-C
Mixolydian	TTSTTST	G	G-G
Hypomixolydian	TSTTTST	G	D-D
Aeolian	TSTTSTT	A	A-A
Hypoaeolian	STTTSTT	A	E-E
Locrian	STTSTTT	B	B-B
Hypolocrian	TTTSTTS	B	F-F
Ionian	TTSTTTS	C	C-C
Hypoionian	TTSTTST	C	G-G

Some of the church modes remain in use, especially in the traditional liturgy of the Roman Catholic Church. Some also are found in folk, jazz, and contemporary popular music, reflecting considerable rejuvenation of interest in them in the latter half of the twentieth century.

Many other modes have been developed in Western cultures, but only a few have gained much acceptance. Perhaps Debussy's *whole-tone* scale is the most successful. It divides the octave into six whole tones, and only two basic whole-tone scales are possible: C, D, E, F#, G#, A#, C and C#, D#, F, G, A, B, C#. The purpose of the whole-tone scale was to break away from the strong feeling for the tonic which traditional harmony elicits. Shepard (1999, p. 187) comments that the whole-tone scale lacks the feeling of motion one finds in asymmetric division of the octave. Indeed, three fundamental aspects of tonal harmony–perfect fourth, perfect fifth, and leading tone–are omitted, thereby dulling any strong tonic sense.

Pentatonic scales have five tones to the octave and have developed in other cultures as well as Western cultures. The pentatonic scale commonly used in Western cultures has no semitones and in the key of C uses the tones C, D,

E, G, A, C. Pentatonic scales can be built on any tone of the chromatic scal within each pattern they also can use any of the five tones as a tonic, thu having five different modes in a manner similar to the church modes. I practice, however, only two modes are used to any extent; the authenti mode, using C as the tonic, and the plagal mode, using G as the tonic.

The *chromatic* scale represents another modal system that has received certain amount of use in Western cultures, mostly in terms of serial musi *Quarter-tone* scales, dividing the octave into twenty-four parts by halving th semitones, also exist.

Backus (1977, pp. 148–149) notes three other suggested scales, whi divide the octave into 19, 31, and 53 parts respectively. He notes that son combinations of the resulting small intervals closely approximate the ju semitones, thirds, and fifths. Von Hoerner (1975) developed an elabora scheme of chords, intervals, and chromatic properties of the 19 and 31 to scales. Perceptually, tiny adjacent intervals become difficult to distinguish.

With developments in computers, synthesizers, and other electro equipment, it is possible to construct many varieties of scales. Such scal sometimes called *synthetic* scales, are intended to be unique and therefore a of little interest other than in relation to the particular compositions in whi they occur.

Modal organization in music of other cultures offers a great variety of ad tional modal patterns. Descriptions of even the most common of these beyond the scope of this discussion, although some are mentioned as exampl

Equally tempered scales also have been developed in the Ori (Farnsworth, 1969, pp. 23–25). The Siamese divided the octave into sev equal parts. Pentatonic scales, somewhat approximating the authentic mo of the Western pentatonic, have been used in many ancient cultur Chinese, Polynesian, African, and Native American (Apel, 1969, p. 65 Chinese music also uses six-tone (sexatonic) and seven-tone (heptator scales, while microtones (intervals smaller than a semitone) characte scales of India and the Middle East.

The possibilities of modal organization in music are infinite, but appar ly only a few modal systems have gained widespread acceptance. Reasons this are primarily cultural, although the compatibility of a scale structure w laws and principles of perceptual organization also appears to be a factor.

Other Types of Pitch Organization

That the twentieth century gave rise to new ways of organizing pitch st ture was mentioned earlier. Lest other discussions suggest that pitch org zation is possible only within certain conventional frameworks, the pre discussion briefly overviews selected twentieth-century Western deve

ments in pitch organization.

The use of chromaticism and the resultant dissonance of the late romantic composers, particularly Wagner, led to a search for pitch organization beyond that which triadic harmony could provide. Chromaticism and modulation had evolved to the point that many composers no longer ended compositions in the original tonic key, in accordance with baroque, classical, and early romantic practice.

Three distinct developments regarding harmonic practice evolved during the late nineteenth and early twentieth centuries. Some composers continued to write within the broad outline of a tonal harmonic framework, while simultaneously using chords of far greater complexity than traditional triads. A second group of composers continued to use chords from earlier harmonic practices, but sequenced them in such ways that expected progressions and resolutions were not forthcoming. Whole-tone music and polytonality were two results of this development. The third development was abandoning tonality for Schoenberg's serial techniques, which are intended to disrupt any feeling for tonality. Serial techniques, often called 12-tone techniques because each of the 12 semitones in an octave must be used before repeating another, aroused new interest in structuring the vertical dimension of pitch polyphonically, i.e., in terms of combinations of independent melodic lines. Twentieth-century polyphony, however, differs from earlier baroque, classical, and romantic polyphony in that there is little concern for the vertical sonorities of traditional tertian harmony.

Three other developments of twentieth-century pitch organization also deviate from the practices of tertian harmony. *Aleatoric* or *chance* music introduces unpredictability regarding either its composition or performance. Such music leaves some of the pitch, duration, and loudness structures to chance, thus making it very difficult for listeners to develop any melodic or harmonic expectations other than uncertainty itself.

In *musique concrete* traditional sound sources (instruments and voices) are enhanced or replaced by various other sounds–environmental noises, sounds of nature, or most any other conceivable sound source. The composer can record, combine, and modify such sounds at will, especially with modern recording and synthesizing technology. *Musique concrete* may utilize fixed or changing pitches as well as sounds of indefinite pitches to create a collage of sounds. As might be expected, the pitch structure need have no confining framework such as tertian harmony, although one may assume that most composers creating music of this type do so in accordance with some underlying organizational structure.[15]

[15]Pitch, of course, is not the only basis for musical organization. Rhythm patterns or timbral similarities may provide order to widely diverse pitch structures.

A final and perhaps most important development in pitch organization of twentieth-century music was electronic music, which with computers, synthesizers, and sound samples gave composers a new vista not only for organizing pitches, but also for creating and modifying new timbres and textures. Composers using an electronic medium can generate and combine pitches in an infinite variety of ways. No longer are the fixed divisions of an octave the basis for all music. The implications of electronic developments are staggering from a music perception standpoint, not only because of possible stimulus arrangements but also because of possible limitations in human respondents.

Developments in serial music, aleatoric music, *musique concrete*, and electronic music have created ambiguities for listeners accustomed to hearing only music constructed in a tonal harmonic framework. At present, the acceptance of such developments in "classical" music appears to be only among a relatively small musical subculture of composers, theorists, musicians, and other listeners. Electronically generated, modified, and/or reproduced sounds are a part of virtually all popular music today. The general population of Western cultures, including many people who profess to having "considerable interest" in music, however, are not flocking to the concert halls to hear or buying recordings of music that deviates too radically from tonal harmony. Whether this is just a normal slowness to accept new musical styles or whether it is because the music of these new developments lacks an organizational structure that allows listeners to perceive and cognitively organize the tonal structures is subject to conjecture.

Psychological Processes

Chapter 4 examined the processing of individual pure and complex tones; this section examines the psychological processes related to pitch structures in *music*. Much theory and research has sought to elucidate the internal higher level cognitive representations and strategies for processing musical stimuli. Most theory and research has been in relation to melodic organization of Western tonal music, although some work has extended to rhythmic and harmonic structures. Also, efforts have been made to establish extended, elaborate hierarchical models of musical perception.

The impetus for this surge of interest in music's cognitive structures is an outgrowth of a major shift in psychology toward focus on "higher level, more cognitive aspects of human behavior" (Krumhansl, 1983, p. 29) and several other developments. According to Krumhansl, the primary influences were Chomsky's (1965, 1975) linguistic theory, with its insistence that language behavior depends on abstract mental representations of linguistic structures, and developments in computer technology, which allowed the development

of models and terminology for characterizing complex mental behavior as well as greatly facilitating precision in controlling research variables and analyzing data. Other influences, also noted by Krumhansl, were that two seemingly contradictory approaches for examining music perception provide important bases for research on cognitive processes. These include (a) the "reductionistic" approach, reflected in the early work of Helmholtz (1863/1954) and Seashore (1919, 1938), which broke down complex auditory perceptual stimuli for examination in terms of sensory response to basic stimulus units; and (b) the work of Gestalt psychologists (Koffka, 1935; Wertheimer, 1923/1955) in developing laws of perceptual organization. Other important influences Krumhansl recognizes come from music theory, which had (a) identified organizational principles for tonal music, (b) developed a terminology for characterization of pitch development, and (c) identified a number of music-theoretic accounts of the nature of psychological processes in music perception.

Psychological processes are examined here as they relate to (a) hierarchical perceptual structures, (b) empirical studies of perception and memory, (c) melodic and harmonic expectations and information theory, and (d) pitch-related behaviors.

Hierarchical Perceptual Structures

A number of hierarchical perceptual models exist; West, Howell, and Cross (1985) provide excellent reviews of some of the more influential ones. They also remind us that models are *analogues* that attempt to portray the psychological processes of music perception, and as such involve making inferences about how subjective experiences of musical sound stimuli in our senses and imagination may affect musical judgments and other behavior. Essentially, *models are descriptions of inferred psychological events.* They also are generalized, usually not accommodating individual differences. Nevertheless, most of them offer valuable insights into music perception, cognition, and behavior.

West, Howell, and Cross's (1985) observations and principles regarding hierarchical cognitive structures in music, noted in Chapter 5, are reiterated briefly here because they provide an important perspective regarding hierarchical perceptual structures. Essentially, model developers should recognize that (a) a model should reflect and accommodate all perceptual dimensions of musical experience; (b) each listener brings a unique history of past music experience to each new music experience; (c) even sophisticated listeners do not immediately perceive, organize, and classify all music in a well-ordered hierarchy; (d) the theory should be verifiable in terms of behavior of particular listeners; and (e) extramusical or historical context may influence

structural grouping. Their three modelling principles are that (a) models must account for both vertical and horizontal structures, (b) grouping principles of Gestalt psychology–good continuation, proximity, similarity, regularity, symmetry, and common fate–reflect global perceptual factors that operate in the context of cultural expectations, and (c) groups formed from Gestalt principles may form larger groups at higher hierarchical levels.

It is beyond the scope of this discussion to review all proposed perceptual hierarchies; however, for illustrative purposes two are examined briefly: (a) Krumhansl's (1979, 1990) *tonal hierarchy* for Western tonal music and (b) two aspects of Lerdahl and Jackendoff's (1983) model that pertain to pitch structure, *time-span reduction* and *prolongation reduction.* (Chapter 5 examined the aspects of Lerdahl and Jackendoff's model relating to rhythmic structures.) Readers interested in examining these models in detail are referred to the original sources.

Krumhansl's theory evolved from a series of experiments about the processing of pitch patterns in a tonal context. In one experiment, musical subjects listened to a C major scale or triad, followed by paired tones. Subjects rated the tonal similarity within each pair on a 1–7 scale. Generally, tones from the C triad were rated as quite similar; other tones from the C major scale were rated as somewhat less similar, and nondiatonic tones (tones other than the scale tones) were rated as less similar yet. The second tones tended to have larger similarity effects (i.e., the pair was rated as more similar) when the second tone was related more closely to the tonal context than the first tone.

In the second experiment, subjects heard patterns comprised of a standard tone, followed by eight interpolated tones and a final comparison tone, which either was the same as the standard or differed by a semitone. The task was to indicate on a 1–6 scale the certainty that the comparison tone matched the standard. Interpolated tones were either tonal, i.e., the standard was in the tonal context suggested by the interpolated tones, or atonal, i.e., the standard was nondiatonic in relation to the interpolated tones. In general, it was easier for subjects to remember diatonic standard tones when the "interference" was caused by diatonic interpolated tones. It was easier to remember nondiatonic tones when the interpolated tones also were nondiatonic. A similar third experiment in which the interpolated tones were free of test tones yielded similar results. In a fourth experiment, subjects judged tonal sequences to be more "musical" than atonal sequences.

Krumhansl applied multidimensional scaling techniques to the similarity ratings and described a *tonal hierarchy.* The multidimensionality is represented by a three-dimensional cone, with the components of the tonic triad lying close together near the vertex. The next level, farther from the vertex, is a less closely related subset consisting of the remaining diatonic scale tones

Still farther from the vertex is a widely dispersed grouping of the nondiatonic tones remaining from the chromatic octave. In other words, in a tonal context the tonic triad (e.g., C-E-G in C major) has perceptual similarity among its components that is greater than any other similarity. The similarity among remaining scale tones (D, F, A, B in C major) is greater than that among nondiatonic tones (e.g., Bb, Db, G#). Perceptual similarities arising from experience with tonal contexts may be critical in guiding the perceptual tracking of a melody.

Butler (1989, 1990a, 1990b) takes issue with Krumhansl's tonal hierarchy theory, arguing that the theory "does not describe how listeners perceive those relationships as they unfold during the music listening act" (1990a, p. 7), and proposes an alternative theory as a basis for explaining listeners' abilities to recognize the tonic. Butler maintains that listeners base their choices of the most plausible tonic for a given musical excerpt on clear statements of *rare intervals* (minor seconds and tritones) within the excerpt. "The dominant-tonic succession that these temporal arrangements of rare intervals represent are characteristic to harmonic cadences in tonal music, and are seldom encountered in atonal music" (p. 9).

In response to Butler's criticism of the tonal hierarchy theory, Cuddy (1991) devised two studies which she claims reaffirm the privileged position of the ascending major triad, which is the core of Krumhansl's tonal hierarchy, thus strengthening the tonal hierarchy theory. Her first experiment asked subjects to judge the suitability of each of the twelve chromatic scale tones as a tonic for eight melodic test patterns: ascending and descending major triads, fifth patterns, minor triads, and diminished triads. Her results revealed that of the responses to the eight melodic patterns, responses to the ascending major triad most clearly defined the tonic as the key tone. In her second experiment, Cuddy asked a different group of subjects to rate the same eight melodic patterns for their "structural goodness." Again, respondents rated the ascending major triad as eliciting the highest level of structural goodness.

Smith (1997) notes that tonal consonance is highly correlated with key context stability, and while being careful not to imply causality, he suggests that tonal consonance may lead to more frequent use of such chords within a key, thus leading to greater key context stability. This in turn may help "account for the tonal hierarchy for tones in both major and minor keys" (p. 175).

Without having any data to substantiate it, the present authors surmise that the tonal hierarchy theory and Butler's rare interval theory may be two sides of the same coin, and the side that one sees may be determined by the nature of the experimental methodology employed to test the theory. Musicians experienced with music constructed within the Western tonal harmonic

framework most likely would find either the tonal hierarchy data or the rare interval data convincing when considered in isolation from the other; both positions have an intuitive "correctness" about them. The tonal relationships of Krumhansl's hierarchy appear congruent with musicians' experiences, but the strong dominant-tonic pull evoked by the rare intervals also is consistent with musicians' experiences. Undoubtedly, more research and discussion will occur. Whatever subsequent research is forthcoming relative to the two positions, and the possible influence of tonal consonance, the reader must remember that both theories deal with inferred cognitive processes based on perceptions of musical events rather than the music's actual acoustical structure.

Lerdahl and Jackendoff's (1983) elaborate hierarchical model of tonal structure is based more on theory than on research. Two of its hierarchical components, *time-span reduction* and *prolongation reduction,* concern pitch structures. As the name implies, the time-span reduction hierarchy seeks to formalize the way in which listeners perceive pitch events at different levels of structural importance within a given time-span. It involves examination of pitch within various levels of the hierarchical "tree" for that time-span, seeking to determine which pitch is most stable. That pitch is called the "head" of the time-span. The process is repeated hierarchically for groupings of time-spans, until the deepest, most abstract grouping level is reached.

According to Lerdahl and Jackendoff, two types of rules are applied in forming structures: *well-formedness* rules, which specify *possible* structures, and *preference* rules, which specify *probable* structures, i.e., the structures that are likely to conform to the way experienced listeners organize the music. Well-formedness rules may answer the question "What's possible?" Preference rules may answer the question "What corresponds to expectancies?" Well-formedness rules for time-span reduction are concerned with specifying the nature of time-span heads; preference rules for time-span reduction specify principles according to which time-span head is chosen.

Essentially, time-span reduction "is intended to account for the distribution of structural and ornamental [pitch] events in a piece, and to give a clear picture of the network of interconnected regions governed by these events" (Clarke, 1986, p. 6). Clarke cautions that time-span reduction presents an essentially static and primarily spatial perspective on pitch organization in tonal music and that it ignores the dynamic properties operating within and beyond the boundaries of the time-span units.

Prolongation reduction attempts to overcome this problem. Whereas time-span reduction works from small groupings to larger, more abstract groupings (from surface to depth), prolongation reduction works in the opposite direction (from depth to surface). Showing some Schenkerian influences, prolongation reduction begins with a simple pitch event, perhaps represent-

ing an entire piece or section, and "elaborates this single event until a level of detail close to the musical purpose is reached" (Clarke, p. 6). Prolongation reduction essentially assigns pitches hierarchical positions based on tension-relaxation and continuity. Prolongation reduction also has a hierarchical tree structure, and well-formedness rules for prolongation reduction are similar to those for time-span reduction. Preference rules select a hierarchy in terms of melodic and harmonic stability and principles of harmonic progression derived from music-theoretic considerations.

As West, Howell, and Cross (1985, p. 39) state, the "model attempts to provide a symbolic representation of music that elucidates its structure as perceived by a listener." Lerdahl and Jackendoff suggest that the model provides a musical "grammar," which includes innate aspects arising from inherent cognitive organization. Just as people are "naturally" predisposed to acquire language, although the particular language they acquire is a function of learning, people may be "naturally" predisposed to acquire music cognition, although the cognitized musical idioms and forms will depend on cultural experience and learning. Variation is possible in language and music, but there are limits to that variation.

Empirical Studies of Perception and Memory

Much recent research on music cognition has focused on perception and/or processing of melodic patterns, primarily ones presented in a tonal context. This focus contrasts with earlier traditional research in music psychology that tended to dwell on responses to single pitches, durations, or chords. Contemporary concerns in music cognition focus on cognitive processes related to musical structures.

Serafine (1983) sees three categories of cognitive processes for music: (a) *global, field-defining processes* that facilitate characterizing a musical piece's general nature; (b) *temporal processes* that involve groupings of both successive horizontal events and simultaneous vertical events into units and groups of units; and (c) *nontemporal processes* that include more abstract processes such as *motivic* or *rhythmic abstraction, transformation, closure,* and *hierarchical structuring.* The research examined herein generally fits into the third category, focusing on studies related to perception and/or processing of selected melodic and harmonic tasks.

Examining hierarchical structuring of compound melody, Serafine (1983) tested the assumption that, in certain types of melodic passages, listeners are able to abstract "an underlying structure that embodies two or more simplified or more basic melodies" (p. 9) from a single melody line. Subjects heard three musical examples: (a) a short piece; (b) a *reduction* of the piece to its "more basic structural tones"; and (c) a similar but "wrong" reduction, i.e.,

with tones not basic and structural. Both the "correct" and "wrong" reductions were presented at different structural levels, i.e., at *foreground* and *middleground* levels. Subjects (adult nonmusicians) were able to select the correct over the wrong reduction at the foreground level, but not at the middleground level. Serafine concluded that her data provide evidence of an initial level of structuring for untrained listeners and that, perhaps even more importantly, the data provide evidence that hierarchical structurings are legitimate cognitive processes rather than just theoretical constructs.

Dowling and Harwood (1986, pp. 130–144) summarize a series of studies suggesting that contour, interval size, and tonal scale system are important features in adults' perception of and memory for melodies and that these features may have different importance, depending on the task's demands. Contour is a particularly important feature for short-term memory tasks, but for long-term memory, where many melodies may share similar contours, interval size plays a much more important role in helping adults differentiate among melodies. Dowling and Harwood also recognize the importance of individual differences in musical experience for music cognition, particularly with respect to employing learned melodic features, such as the tonal scale system, for processing melody.

Idson and Massaro (1978) conducted a series of experiments involving structural transformations of melodies to evaluate the effects of interval size, contour, tone height, and tone chroma on melodic recognition. In two transformations, a melody's component tones were replaced by octave intervals, either preserving or violating the patterns of change in pitch direction (melodic contour). When contour was violated, melodic recognition was disrupted severely, but when contour was preserved, subjects identified the transformed melodies as accurately as the untransformed melodies, suggesting that contour, as well as interval size, provides essential information for melodic perception.

Cuddy, Cohen, and Miller (1979) provide evidence that diatonic conditions and cadential relationships are important information for maintaining melodic structures and recognizing deviations from those structures. Forty-eight subjects with "general interest in music" indicated which one of two transpositions of standard melodies was correct. Each transposition was either to the dominant (e.g., G in relation to C) or tritone (e.g., F# in relation to C) tonality in relation to the particular standard's diatonic context. Altered tones, which made particular melodies "wrong" in relation to their standards, were a semitone up or down from where they would have been in a totally accurate transposition. Subjects' performance deteriorated when the "core" of three tones containing the alteration was embedded in a nondiatonic context; it improved when a cadence was provided. The most accurate recognition occurred when (a) there was a diatonic and cadential context, (b) the

altered tone was nondiatonic, and (c) the transposition was to the dominant level. The worst recognitions occurred under nondiatonic conditions. Essentially, the study yielded important evidence that musical structures provide aids that people who are sensitive to those structures might employ in recognizing alterations in a tonal sequence.

Cuddy, Cohen, and Mewhort (1981) asked 120 undergraduates to rate short melodic sequences in terms of tonality or tone structure, with highest ratings for sequences with "musical keyness" or "completeness" and lowest ratings for sequences that contained "unexpected" or "jarring" tones. The seven-tone melodic sequences reflected five levels of harmonic structure; in addition, they varied in two other dimensions, contour and excursion. Contours essentially were simple or complex, depending on the number of direction changes, and excursion was either zero or nonzero, depending on whether the sequence's final tone was the same as or differed from the first. In a second experiment, 60 students selected the position of the correct transposition of the test sequence. A third experiment employed procedures similar to the second, but used on-line computer-generated sequences. Results of experiment one revealed that as the rules of diatonicism were violated, i.e., as the harmonic structure changed from the highest level of diatonic tonal structure to sequences that deviated radically from diatonic tonal structure, there was a dramatic change in ratings. Both highly trained musicians and subjects with little formal training rated the sequences consistently according to the harmonic structure. Experiments two and three revealed that subjects were able to identify correct transpositions with greatest accuracy for melodic sequences with the highest level of harmonic structure and with the simplest contour and excursion. In a subsequent experiment using a similar but more difficult task, Cuddy (1982) confirmed that the variables of structure, contour, and excursion held even when mistunings were introduced in the melodic sequences.

Implicit if not directly suggested in each of the above studies is the dependence of perception and memory on the tonal harmonic framework of the melodic pattern. Apparently, people most easily recognize and remember melodies that conform most closely to the rules and grammar of Western tonality. Such findings are consistent with Krumhansl's tonal hierarchy.

The dependence of Western music and the Western listener on harmonic structure and tonality for remembering melodies also affects performance. Sterling (1985) examined the effects of stylistically diverse harmonizations on 25 college singers' performances of an unfamiliar tonal melody that they had learned to a specific criterion level. The harmonizations included traditional tonal, chromatic, dissonant, quartal, and chords with extensions. Results revealed a higher degree of vocal accuracy when traditional tonal harmony accompanied the melody, suggesting that tonal harmonic structure affects

singers' reproductions of melodies.

The potential of research on music perception and cognition for understanding and facilitating musical behavior appears great, although few efforts have been made to "apply" the results as part of structured music pedagogy. Perhaps the research base is as yet insufficient for such application, but the challenge remains for both psychologists and educators to interpret and apply such findings.

Expectations and Information Theory

The vast array of musical stimuli comprising melody and harmony, with their inherent attributes of tonal and rhythmic structure, timbral variations, and dynamic change, presents listeners with a stimulus complexity that, without some mechanism for creating perceptual order, might appear as unintelligible cacophony. Indeed, to some individuals, much of what others call music *is* unintelligible cacophony! The question under consideration here, therefore, is "How do individuals create musical meaning out of the mass of sounds called melody and harmony?"

From a psychological perspective, melody and harmony are highly complex, but most individuals apparently can derive a certain amount of musical *meaning* from them.[16] Many individuals who appear to gain meaning from music, however, have no extensive or intensive formal musical training. On the other hand, even some highly trained musicians apparently perceive little meaning from some avant-garde music. Members of Western culture also can listen to a given Oriental melody and have great difficulty in recognizing any semblance of organizational structure. Still, some individuals within a Western culture can listen to Brahms' *Symphony No. 2 in D Major* and marvel at its structure while others perceive it as unintelligible cacophony. Such observations beg the question, "Why does music hold meaning for some individuals and not for others?" One approach to the question involves information theory (e.g., Broadbent, 1958; Meyer, 1956, 1967, 2001; Moles, 1966). This approach recognizes that a central problem in dealing with complexity is an individual's *capacity* for such. Capacity for perception and cognition of complex stimuli is limited for everyone, although individual limits vary. We do not know how to assess the limits of perceptual capacity except under somewhat artificial conditions for some isolated tasks. Information theory provides a construct for examining perceptual capacity for music.

Information theory basically is a system for quantifying *uncertainty* in a sensory stimulus or *message*. "A message is a finite, ordered set of elements of perception drawn from a repertoire and assembled in a structure" (Moles,

[16]As used in the present discussion, musical meaning refers to perceptual and conceptual meaning; Chapter 8 examines musical meaning as aesthetic meaning.

1966, p. 9). Messages may be spatial or temporal; music, like dance, is a time-based art and provides largely temporal messages, whereas painting, sculpture, and photography provide largely spatial messages. The amount of information a message contains is a function of probability. If a message could contain only one symbol, correctly identifying the message's content provides zero information: If the message exists at all, it only can convey the one symbol. If the message could contain one of two equally likely alternative messages, correct identification provides one *bit,* or one binary decision's worth of information (Watson, 1973, p. 293). The greater the amount of *information* the message conveys, the less the *redundancy,* and the greater the *uncertainty of meaning or response.*[17] In theory, a mathematical formula can predict the probability of a response, but the complex nature of melody and harmony, coupled with the human variable in terms of previous experience with melody and harmony, makes absolute accuracy of prediction virtually impossible.[18] The authors concur with Meyer (1967, p. 20) that our inability to measure precisely the amount of information in a musical message does not weaken or invalidate information theory as a basis for examining musical meaning. The theory still provides a useful construct for examining musical expectation as well as a framework for studying musical perception.

The amount of *information* an individual receives when listening to melody or harmony, and hence an individual's *expectations* regarding them, is a function of two basic variables: (a) the extent to which the *structural* characteristics of melody and harmony conform to fundamental laws of perceptual organization and (b) the individual's previous experience with the given melodic and harmonic style. As should be apparent from previous discussion, melodies and harmonies that conform most closely to the rules and grammar of Western tonal harmonic structure generally conform to the fundamental laws of perceptual organization. The tonal harmonic framework provides the structural unity, and the listener perceives the melody or harmony as a Gestalt or holistic pattern.

The expectations an individual develops from experience with melody and harmony are related to their *perceptual redundancy.* While information theory per se holds that a message's redundancy is characteristic of the stimulus alone, Meyer (1967, pp. 277–279) maintains that redundancy in a musical message depends both on the extent to which structural characteristics conform to the laws of perceptual organization (structural redundancy) and

[17]This may seem puzzling if one thinks of "information" only as clarification or repetition. In information theory, information is nonredundant or new. In a simple visual comparison, the message A A A A A A A A contains less information and less uncertainty than A B C B C because the shorter string of letters has less redundancy.

[18]Specific quantification of information in music is also complicated considerably by conflicts regarding what the basic *unit* of musical information is: Is it the individual tone, a chord, a phrase, or a period? It probably varies with the music and the listener.

the degree to which the individual has learned the syntactical-formal premises of the musical style (cultural redundancy). Perceptual redundancy = structural + cultural redundancy.

Redundancy is never total, even in a musical style with which an individual is familiar; melody and harmony in Western tonal music have some disorder, ambiguity, and unpredictability. Meyer (1967, p. 278) notes that a totally redundant composition would be extremely boring due to its complete predictability; perceptual information comes from the unexpected aspects that complement redundancy. Meyer (2001, p. 348) also notes that the eventual dissipation of tensions aroused by musical uncertainty helps to unify the structure of a composition.

Perceptual redundancy, which varies with the individual listener, relies heavily on memory of previous experiences (long-term memory) with the style and allows the individual listener to create psychological order out of the melody or harmony, thus developing expectations and meaning or understanding. If redundancy is too low, the perceptual information is too great for the listener to understand the melody or harmony. If the redundancy is too high, the music is so predictable as to become quickly boring.

As may be apparent to the reader, the harmonic framework of Western music, with its melodies and harmonies using a familiar scale system and constructed in such ways that tonality and melodic and harmonic movement are built in, gives the musical stimulus redundancy. Regardless of the historical period and its stylistic peculiarities, tonality and scales provide strong *structural redundancy.*

When an individual with his or her lifetime of experience with Western tonal music, which Meyer calls *cultural redundancy,* listens to unfamiliar tonal music, which has *structural redundancy* due to its tonal harmonic framework, the *perceptual redundancy* is high, thus limiting the amount of new or extraneous *information* in the music. Hence, the individual more readily can "make sense" of the unfamiliar music than he or she could if it were in a style that did not have structural redundancy and for which he or she had developed no cultural redundancy.

This does not mean, however, that everyone maturing in a Western culture automatically will understand all tonal music, because within Western culture the variety of musical style is great; furthermore, the range of musical experiences individuals within a Western culture have also is great. It does suggest, however, that if given adequate experiences with tonal harmonic music, an individual should have a strong psychological basis for interacting with it.

To recapitulate, perceptual redundancy limits the amount of information a listener receives from a musical message. The greater the redundancy, the less the information and the less the uncertainty. The less the redundancy,

the greater the information and the uncertainty. The greater the redundancy, the more accurate the listener's expectations because there are fewer uncertainties. Perceptual redundancy, comprised of structural and cultural redundancy, enables a listener to conceive melody and harmony as patterns or *Gestalten* even though he or she obviously may not perceive and remember each constituent tone or chord of the pattern. The expectations complement the tones and chords actually perceived to create the musical pattern.

When a listener encounters melodies or harmonies that have little structural redundancy and for which he or she has not developed cultural redundancy, there is increased information. With the increased information (and increased uncertainty), the accuracy of the individual's expectations decreases. When information is so great that the individual can not develop expectations regarding the melodic or harmonic patterns, the music holds little meaning. Meyer (1967, pp. 283–293) suggests that the *lack* of perceptual redundancy, with its constituent aspects of structural and cultural redundancy, is most likely the reason serialism failed to gain widespread acceptance. The authors submit that some avant-garde electronic music that does not provide structural redundancy also will be unlikely to gain widespread acceptance, particularly since few individuals are developing cultural redundancy for such music.

Research on Musical Expectancy

Interest in how people develop musical expectancies has given rise to both theory and research. Jones (1981, 1982) developed an expectancy model suggesting that musical expectancies result from the interplay between *ideal prototypes* and *ordinary patterns.* Ideal prototypes are the simple perfect symmetries that underlie a particular style; they are abstract representations of melodic, harmonic, and rhythm patterns that probably exist only in laboratory settings as ideal standards of the given style. Jones's ordinary patterns are more complex and reflect interesting deviations from the ideal patterns. She suggests that expectancies are formulated when ordinary patterns deviate from the idealized symmetries of the ideal prototypes. The discrepancies between the two types of patterns result in an element of surprise, which in turn facilitates perception and retention of the musical sequence. The theory presumes a musical system with built-in order and consistency, such as the tonal harmonic framework of Western tonal music.

Carlsen, Divenyi, and Taylor (1970) examined the effects of two-tone melodic intervals (or "contexts"), which they considered to be *expectancy-generating stimuli,* on music students' melodic continuations of the patterns. While the study was essentially exploratory, the results revealed that subjects' responses for certain intervals tended to cluster and that it was possible

to develop *melodic expectancy profiles* for certain intervals.

A subsequent study using the same technique (Carlsen, 1981) sought to develop expectancy profiles for various intervals. This study revealed that different intervals not only generated different expectancy profiles, they also yielded different expectancy-generating strengths. Ascending major and minor seconds, the descending minor second, the ascending minor sixth, and the ascending and descending minor seventh all generated strong expectancies. Carlsen also observed that subjects from different cultures tended to generate different continuations, supporting the view that music expectancies depend on previous experiences.

After gathering data on listeners' melodic expectancies, Unyk and Carlsen (1987) developed a unique set of 24 short melodies for each subject, based on each individual's expectancy profile. The 24 melodies, used in a melodic dictation task, represented two levels of expectancy strength at each of three levels of expectancy: (a) fulfilled, (b) fulfilled contour but with violated interval size, and (c) both unfulfilled contour and interval size. The results revealed that each melodic pattern produced distinct patterns of response, which were similar to the expectancies of Carlsen's (1981) study. Melodies with strong expectancy generators yielded significantly fewer dictation errors for melodies with fulfilled contours and interval size than for the other two expectancy levels. However, for melodies with weak expectancy generators, violated expectancies did not result in significantly more dictation errors than melodies with fulfilled expectancies. Unyk and Carlsen suggest that their results support the theories of Meyer (1956, 1967) and Jones (1981, 1982) that listening to music involves formulating expectancies about future events in the unfolding musical pattern. For melodies with strong expectancies, violations of expectancy lead to reduced ability to identify and recall the musical events.

Schmuckler's (1988) four-part study examined factors underlying the formation of (a) melodic expectations, (b) harmonic expectations, (c) expectancies for a full musical context, and (d) skilled pianists' performances of music expectations. Using a modified version of the probe tone technique devised by Krumhansl and Shepard (1979) and stimuli derived from the vocal line of a Robert Schumann song, Schmuckler asked musically trained subjects to rate how well each of ten continuations, each of which presented a different stopping point or probe position of a stimulus, fit the context or their expectations of what should come next. Schmuckler averaged the subjects' data for the various continuations; he referred to the averages as *melodic expectancy profiles.*

Schmuckler's melodic expectancy profiles confirmed that some continuations are more expected than others. To determine tonality's influence on the profiles, Schmuckler correlated the average ratings for the 10 probe positions

with prior data on the perceived tonal stability of chromatic scale tones in reference to a tonal context (Krumhansl & Kessler, 1982). These ratings, which Schmuckler termed *ideal key profiles,* then were used to assess tonality's effects on melodic expectations. Schmuckler suggests that by defining a certain key space from which the expected tones are drawn, tonality does influence expectations: It increases the probability of certain continuations while simultaneously decreasing the probability of others (p. 69).

Schmuckler's second experiment tested whether harmonic sequences generated specific expectations for an upcoming chord (p. 94). In brief, Schmuckler found that listeners generally anticipated the chords typically found in common chord sequences in Western tonal compositions. He notes that "global features of a harmonic passage, such as larger context, or the general musical form, also guide expectancy formation" (p. 96). Also, he observed that listeners generally were more accurate in their anticipations for harmonic events than for melodic events.

Schmuckler's third experiment examined expectations in a full musical context, apparently combining the melodic and harmonic stimuli from experiments one and two. As might be expected, listeners' expectations about upcoming musical events were very accurate, perhaps an additive effect of their melodic and harmonic expectations. As Schmuckler states, the "predictability of the harmonic context makes the melodic implications clearer" (p. 119).

Schmuckler's fourth experiment examined performances of six experienced pianists' expectations; specifically, it sought to determine whether expectancy profiles generated by performers were similar to the expectancy profiles generated in the earlier experiments. The pianists were asked to complete the performance of the musical stimuli used in experiments one, two, and three. The six subjects' melodic continuations varied considerably in length, but the performers' first tones "tended to agree with the ratings of different melodic expectations from Experiment 1" (p. 126); however, there was only moderate agreement among the balance of the six performers' melodic continuations. Harmonic continuations were weaker than the melodic continuations, but "there was reasonable correspondence between the harmonic expectancy profiles and the performed chords" (p. 129). The strongest correspondences between performer-produced continuations and the expectancy profiles were for the full-context condition. Schmuckler cautions that the results of experiment four are tentative yet very suggestive, noting that "the relatively strong correlations between the expectancy profiles of Experiments 1–3 and the initial performer-produced events provide evidence that the ratings gathered in the first three Experiments did accurately reflect what listeners expect to happen" (p. 134).

Recent research (Tillmann, Bigand, & Pineau, 1998) supports

Schmuckler's findings regarding the importance of music's structure for harmonic expectations. Data, based on 24 graduate music students' and 24 nonmusicians' responses to 20 chord sequences ending on an authentic cadence, revealed that both local (immediately preceding chord) and global (preceding six-chord sequence) factors influence expectations regarding a target chord.

Most of the research cited above considers expectations in terms of structural aspects of melody and harmony, but one must remember that musical expectations occur at multiple levels. Expectations are hierarchical, ranging from relatively low-level expectations about "what's coming next" in a melodic or harmonic sequence to higher level abstractions and expectations regarding musical style. Applying his *implication-realization model* of melodic expectancy (Narmour, 1990) to broader aspects of musical expectancy, Narmour (1999) makes an eloquent case for musical expectations being hierarchical. Invoking both "bottom-up" and "top-down" approaches to developing expectations about musical style, both within given pieces (intraopus style) and between pieces (extraopus style), Narmour maintains that knowledge of both basic structural attributes (e.g., pitches, durations, timbres) and more holistic, complex style parameters is essential. In short, he maintains that musical expectations are hierarchical and that the "level" of a listener's expectations will vary with his or her knowledge of a given piece or musical style. The "top-down" generalizations and "bottom-up" processing will interact in a varying way as the listener adjusts hierarchical relationships to account for musical experience and stylistic familiarity (Narmour, 1999, p. 470). Obviously, Narmour's carefully devised model warrants examination in depth, and readers are encouraged to examine his work directly. It holds many implications for understanding musical expectations, although one must remember that such notation-based models are highly inferential with respect to modeling music cognition and expectation.

This brief discussion of research on musical expectations suggests that Meyer's theory of expectations can be verified empirically. Researchers (e.g., Bharucha, 1994; Jones, 1990; Narmour, 1990, 1999; Unyk, 1990) have extended and refined expectation theory, and their work undoubtedly will provide a basis for much subsequent research in musical expectation.

Pitch-Related Behaviors

Expectations are fundamental to both receptive and production behaviors. While their role in receptive behaviors is apparent, as suggested by the previous discussion, their role is perhaps less clear regarding production behaviors. In melodic and harmonic reception, expectations essentially are a function of memory of previous melodic and harmonic experiences, which

in turn facilitate perception of new melodies and harmonies.

Woodruff (1970) calls memories of previous experiences *concepts* (see also Chapter 10) and suggests that they provide the basis for musical behavior. Regelski (1975, p. 11) elaborated on the view that concepts are general thought tendencies and suggests that they result from (a) perception and cognition of many particular personal experiences with the learning or skill to be mastered, (b) the transfer of certain learning from particular personal experiences to other particular but somewhat different situations, and (c) a gradually evolving tendency toward increased frequency of the particular musical behavior.

Expectations, therefore, are basic to conceptualizing music. Musical concepts, recognized as cumulative tendencies toward response resulting from cognitive musical organizations, are the product of memories and classifications of previous experiences with musical stimuli. While musical concepts involve covert cognitive activity, they form the basis for both receptive and production behaviors. Receptive behaviors essentially are perceptual and therefore covert in nature; production behaviors involve musical production or reproduction.

RECEPTIVE BEHAVIORS. Since receptive behaviors are essentially covert, investigators must devise some overt manifestation to study as evidence of reception. This may create additional questions; investigators do not always agree regarding whether particular overt behaviors validly indicate covert perception or conception. For example, tasks that investigators might devise to study melodic perception might range from simple melodic recognition or discrimination to singing or notating an aurally presented melody. Some "melodies" used in research are limited, contrived tonal sequences that may or may not represent Western melodies. While some investigators define their terms operationally and limit their generalizations, others apply vague labels to their studies and sometimes generalize far beyond what the data justify, thereby leaving the reader with excessive, seemingly contradictory information. Intermixing theoretical considerations with presentations and discussions of empirical data may compound the confusion. Unfortunately, no neat and tidy solutions to such problems exist.

One should recognize that receptive behaviors are essentially perceptual and involve *recognition of* and *discrimination between* musical stimuli. Both processes are fundamental to melodic and harmonic reception. While listening to music, an individual, usually without any particular awareness, constantly separates the familiar from the unfamiliar and compares new patterns with memories of previously learned patterns. The better the new melodies and harmonies match the expectations based on memories of previous experiences, the more comprehensible they are.

Fiske's (1990, 1993) theory of music cognition holds that music listening

essentially can be reduced to a series of comparisons and decisions. According to the theory, music cognition, a uniquely human form of behavior, involves expending time and effort to identify patterns based on their tonal and rhythmic (T-R) relationships. A pattern may be a given pattern (P), a pattern derived from P (P'), or a distinctly different pattern (Pn). When an individual engages in pattern comparison, which is basic to music cognition, he or she must decide whether the second pattern is (a) identical to the first, (b) a derivation of the first, or (c) distinctly different from the first (Fiske, 1993, p. 2).

Two additional classes of receptive musical behaviors are *analytical* and *aural-visual discrimination*. Essentially, these are extensions of recognition and discrimination, but each goes beyond basic receptive processes. Analytical behaviors reflect efforts to consciously categorize melodic and harmonic patterns into their constituent parts. Aural-visual discrimination involves associating aural stimuli, including melodic and harmonic patterns, with their symbolic (notational) representations.

As may be apparent, receptive behaviors are difficult to isolate entirely from performance behaviors; an element of "performance" exists in any overt manifestation of receptive behaviors. Also, failure to produce does not necessarily mean failure to perceive or receive. A person may be unable to sing because of a vocal production problem rather than a reception or perception problem.

PRODUCTION BEHAVIORS. While Chapter 7 examines some research related to production behaviors, an overview of basic types of production behaviors is included here. They include singing, instrumental performance, and creating music, but most musicians believe that the ability to make musical discriminations underlies all production behaviors. Without the ability to discriminate among pitches and pitch patterns, an individual would be unable to produce his or her musical intentions in any tonal manner. While the present discussion concerns melodic and harmonic production, the principle is the same for all musical aspects, be they dynamics, rhythms, or timbres. If the individual can not discriminate among the tonal attributes, production efforts are hindered.

Each of the three types of production behaviors is subdivided according to whether the behavior is a *re*production or *pro*duction of music. Singing and instrumental performance may involve production of melodies and harmonies not previously produced, i.e., improvisation. In improvisation, the performer combines new melodic and harmonic patterns within a given conceptual framework. Most contemporary improvising, be it by a jazz musician or a church organist, is conceived within a tonal harmonic framework.

Singers and instrumentalists also are involved in the reproduction of melodies and harmonies. They may produce pitch patterns learned "by ear,"

i.e., by rote procedures, and patterns read or memorized from notation. At the risk of overgeneralization, it appears that most music performed in Western cultures, at least in formal settings, involves more reproduction than production.

Creative behaviors also can involve either production or reproduction of musical patterns. A favorite pastime of music theory teachers, melodic and harmonic dictation, requires music students to reproduce in notation aurally given melodic, harmonic, and rhythm patterns. Production of notation, however, involves what some consider the ultimate musical behavior, composition.

Development of Melodic and Harmonic Behaviors

The types of receptive and production behaviors are broad enough to enable division into many sublevels or categories. While a developmental taxonomy of melodic and harmonic behaviors might be feasible, the uniqueness of each child's musical experiences is such that any attempt to set forth such a taxonomy immediately would encounter difficulties. Each child's developmental sequence, while subject to general laws of maturation, is necessarily unique because environment greatly influences musical development (Phillips, 1976; Sergeant & Thatcher, 1974). Nevertheless, some generalizations can be made regarding musical development and this section examines them from two perspectives: research-based studies of musical development and music teachers' views.

Research-Based Findings

Research related to development of melodic and harmonic behaviors primarily is developmental, i.e., studies of children's abilities to accomplish certain musical tasks at various age or developmental levels. A major problem with this approach is the gap between the various musical tasks children are asked to perform and the implications drawn from their performances. Investigators may loosely label many varieties of tasks, including ones requiring musical performance, as melodic perception, even though performance tasks obviously involve production behaviors in addition to receptive behaviors. Loose application of labels to assessment of receptive and productive tasks confounds the study of musical development, and the reader is cautioned to consider the required tasks in any given study and to draw conclusions only with due consideration of the task natures.

Another difficulty in drawing conclusions from studies of young children is the notorious unreliability of measuring instruments. Investigators often draw conclusions on the basis of a very limited sample or responses to tests of questionable reliability and validity. These difficulties, coupled with the

uniqueness of each child's musical experiences, make sweeping generalizations about children's musical development hazardous. Nevertheless, a growing body of research reveals increasing consensus regarding melodic and harmonic development, and some of the more significant studies are noted here.[19]

A series of studies by Trehub and her colleagues (Chang & Trehub, 1977; Trehub, Bull, & Thorpe, 1984; Trehub, Thorpe, & Morrongiello, 1987) indicates melodic response begins in infancy. Chang and Trehub monitored five-month-old babies' "startle" responses to changes in six-tone melodic patterns and observed changes of heart rate (acceleration) when a pattern with a different contour was played after the infants had become habituated to another pattern. However, such response was not evident when contour was maintained but transposed up or down a minor third. The 1984 study (Trehub, Bull, & Thorpe) examined the effects of additional melodic transformations (transpositions to other keys, altering intervals while preserving contour, altering octaves with accompanying contour changes) on six- to 11-month-old infants. Using the "operant head turn procedure" as the response measure, the investigators observed that subjects responded to new melodies or tone sequences as *familiar* if the sequences had the same melodic contour and frequency range as a previously heard sequence, but they responded to sequences with either different contour or range as *novel*. The 1987 study (Trehub, Thorpe, & Morrongiello) tested nine- to 11-month-old infants for their discrimination of changes in melodic contour in the context of variations in key or interval size. Results revealed that infants could detect changes in both variable contexts, lending further support to conclusions from previous studies that infants categorize sound sequences on the basis of global, relational properties such as melodic contour. The investigators noted that the absence of response to differences of key and key-plus-interval conditions suggests that infants encode contour, rather than interval, information. In a summative article, Trehub (1993) notes that infants are sensitive to contour and can discriminate between ascending and descending patterns, but they are insensitive to individual pitches and intervals.

Nearly all research on infants' and young children's development of melodic discrimination reveals an increase in skills with an increase in age; however, various studies do not agree regarding the exact ages at which children develop given skills. According to Hargreaves (1986, pp. 68–69), "vocal play," the precursor of spontaneous song, begins during the first year, suggesting that even six-month-old infants possess the prerequisites of music making: the ability to vocalize, vary, and imitate pitch, and detect changes in

[19]Some of the information regarding development appears in a condensed and general way in Chapter 10.

melodic contour.

Sloboda (1985) observed that the first striking change in overt musical behavior after the first birthday comes at about 18 months of age, when spontaneous song begins. "The main characteristic of spontaneous singing is the use of discrete stable pitches (rather than the microtonal glides of the earlier 'song babbling')" (p. 202). Such singing usually does not include words, leading Sloboda to suggest that musical development at this age occurs along a separate "stream" from speech. Spontaneous singing at this level does not appear to reflect efforts to imitate particular songs, although the singing begins to include short melodic patterns using intervals that approximate the seconds and thirds of tonal music.

Most accounts of children's singing during the latter half of the second year suggest a gradual change toward use of melodic patterns reflecting tonal, or culturally "correct," structures in spontaneous singing. They also note an "emerging ability to select melodic fragments from an increasingly large repertoire [of standard songs], and to match these with increasing accuracy to the components of standard models" (Hargreaves, 1986, p. 72). Apparently, children begin to borrow certain aspects of songs they have heard and assimilate them more and more into their own spontaneous songs.

During the third year, children's spontaneous songs appear to become longer and reflect a definite trend toward use of diatonic scale intervals. Davidson, McKernon, and Gardner (1981, p. 305) suggest that children appear to develop a set of song-related expectations that in essence provide a "song frame" which structures their vocal performances. As Sloboda (1985, p. 204) notes, "by two-and-a-half, the child seems to have assimilated the notions that music is constructed around a small fixed set of pitch intervals, and that repetition of intervallic and rhythmic patterns is a cornerstone of music." However, the child as yet seems to lack any grasp of hierarchical structures governing groups of patterns that might prescribe direction and closure. Sloboda observes that songs of children of this age usually have an "aimless" quality, with little or no sense of "finishing."

Toward the end of the third year, children's singing begins to reflect less spontaneous song and more imitation of songs they hear in their environment. Moog's (1976) extensive study of children's musical development revealed that children in the early phases of this stage are able to imitate melodic contour more easily than they imitate exact pitch. However, during the third and fourth years, many children's capacities to imitate songs develop greatly, to the point that "most children can accurately reproduce the familiar songs and nursery rhymes of their culture by the age of five" (Sloboda, p. 205). Spontaneous song is no longer the predominant song style for the five year old. Apparently, children at about age five become much more concerned with accuracy of imitation, reflecting a general developmental trend toward precision and mastery of detail. Five year olds usually are able to maintain the key of a song much better than four year olds, apparently reflecting some higher order "knowledge" of key and tonal center that most four year olds have not yet developed.

The ability to maintain a key or tonal center is not necessarily the same as the ability to learn a song at a given pitch level. Sergeant and Roche's (1973) study of children's ability to learn to sing songs at specific pitch levels suggests that younger children may focus more on the absolute pitch when learning a melody than do older children. Over a three-week period they taught 36 children (13 three to four year olds, 10 five year olds, and 13 six year olds) to sing three melodies. Each melody was taught on an invariant pitch level. One week after the study's completion, each child's singing of the melodies was recorded. Results revealed an inverse relationship between accuracy of pitch level and accuracy of the melodic pattern. The youngest group sang at the most accurate pitch level, but the oldest group sang the melodic patterns most accurately. The results support the investigators' hypothesis that younger children tend to focus on pitch per se, while with increased age and conceptual development they focus more on the attributes of melodic pattern. Sergeant and Roche suggest that absolute pitch skills could be developed if children were trained on fixed pitch instruments during a critical period, common to all children, before higher-order conceptual thinking transcends their preconceptual pitch perception.

McDonald and Ramsey (1979) sought to replicate Sergeant and Roche's study with American preschool children. Seventy-six two through five year olds were taught to sing four songs of invariant pitch levels in six 30-minute training sessions over a three-week period. Their data partially supported Sergeant and Roche's results: There was a positive relationship between age and conceptualization of melody. However, they did not find the inverse relationship between age and pitch level, perhaps due to using a more stringent scoring system for pitch level than did Sergeant and Roche.

A subsequent study (Ramsey, 1983) examined the effects of age, singing ability, and instrumental experience on three, four, and five-year-olds' perceptions of melody as indicated by song vocalization. Ramsey evaluated five melodic aspects: (a) absolute pitching, (b) melodic rhythm, (c) melodic contour, (d) tonal center, and (e) melodic interval. Her data revealed (a) significant differences in the performance of three, four, and five year olds on melodic rhythm, contour, and interval; (b) high ability singers scored higher than low ability singers on perception of melodic rhythm, contour, and interval as well as tonal center; and (c) instrumental and noninstrumental treatment groups did not differ significantly in perception of the melodic components. Surprisingly, the data yielded no significant age level effects on either absolute pitch or tonal center.

Zimmerman (1971, p. 28) notes that a rapid development of melodic perception marks ages six to eight. Petzold (1966, p. 254) and some other researchers, however, report a leveling effect following third grade, or around age nine.

Taylor (1973) notes marked development of harmonic awareness around age nine, but Thackray (1973) maintains that results of his harmonic perception test provide positive evidence that many children develop a considerable degree of harmonic awareness well before age nine. Bridges' (1965) study of harmonic discrimination ability of children in kindergarten through grade three also suggests a gradual development in harmonic discrimination ability. Moog (1976), however, maintains that his research shows unequivocally that preschool-aged children do not experience any sort of harmony at all. Shuter-Dyson and Gabriel's (1981, pp. 147–149) review of several studies examining children's harmonic discrimination in terms of consonance and dissonance (essentially requiring the selection of which version sounded "better" or "correct" in paired comparisons) revealed great improvement between ages five and 10 in selecting "better" or "correct" versions. Such findings lend support to the view that basic harmonic awareness develops as part of children's enculturation with Western music.

Imberty's (1981, pp. 101–115) comprehensive study of tonality development reveals four age-related stages of tonal enculturation: (a) below age six, a period of perceptual *undifferentiation* regarding cadence; (b) from six and one-half to seven years, a *cadential perspective scheme,* i.e., the child considers a musical phrase without a cadence as unfinished, but makes no clear differentiation among differing cadential movements; (c) around eight years, where the child can differentiate between a perfect cadence and absence of cadence and responds to interrupted cadences less clearly; this stage's primary characteristic is the beginning of *perceptive decentration* which enables the subject "to connect what precedes the cadential formula with the formula itself" (p. 113); and (d) around 10 years, characterized by the establishment of a *relation of order;* the perception of the dominant leads to anticipation of the tonic; *reversibility* is evident in the perception of tonal functions, and the syntactic elements of the musical phrase enable the precedence of order and logical anticipation. Imberty's research with older children did not reveal continued development, leading him to recognize a sort of "ceiling effect" that apparently can not be forced higher. Imberty's ceiling effect for tonality occurs at about the same age level as the plateaus for melodic and rhythmic development observed by Petzold (1966).[20]

In summary, melodic discrimination skills appear in infancy and continue to develop through about age eight, with a critical period for development

[20]In general, musical development beyond a certain age/maturity level requires formal musical training, as Chapter 10 notes.

around ages five or six. Perhaps this critical period is reflected in the child's shift from spontaneous song to imitation of songs heard in the child's cultural environment. Harmonic discrimination skills develop later, with earliest harmonic awareness usually appearing around age five or six and with a marked increase around age nine. Whether the leveling in melodic skills around age nine is due to increased harmonic awareness, however, is subject to conjecture.

Music Teachers' Views

The research-based findings discussed above primarily reflect attempts to study children's melodic and harmonic development as a part of their enculturation process with Western music. As children reach school age, musical development becomes more dependent on formal instructional experiences.

The present discussion examines some commonly used methods that music teachers employ for developing melodic and harmonic behaviors. A general instructional sequence at the various elementary school levels emphasizes rhythm in preschool, kindergarten, and the early primary grades. Melody receives greater attention in grades two through four, and harmony begins receiving greater attention in grades four through six. Nye and Nye (1985, p. 272) note that this is the general order in which children develop musical concepts.

The major musical activities for developing melodic and harmonic behaviors include singing, listening, and playing instruments. Movement sometimes is used to reinforce melodic behavior, but it is used primarily to develop rhythmic behaviors.

Although much musical development occurs outside of school, for most children, school music represents their first formal learning experiences with music. The initial pitch-related concept that teachers try to develop in children is *high* and *low* pitch, or more properly *higher* and *lower* pitch, since pitch is a relative phenomenon.

Aronoff (1969, p. 42) notes that young children should develop behaviors related to melodic direction and shape, which various musical activities–singing, listening, and playing instruments–may help develop and reinforce. Children learn that melodies move up, move down, or repeat tones; once they have directional awareness, children can discriminate and describe how a melody moves–by steps or skips, repeated tones, sequences, etc.

While teachers recognize music reading as a developmental process ranging from following simple line notation to reading standard notation, they do not agree regarding the best way to teach reading. Many music educators maintain that reading is best facilitated through instrumental experiences in which the visual symbols stand for particular sounds and sets of movements.

Others advocate a system to foster *relative* pitch reading within a scale or key. The predominant system of this type is the *movable do* syllables, although some teachers use a number system for the eight major scale tones. A *fixed do* system is used primarily in Europe. After reviewing the advantages and disadvantages of syllables and numbers, Gordon (1971, pp. 100–103) concludes that the *movable do* system is best.

Just as research shows that harmonic behaviors develop later than melodic behaviors, music teachers have determined that teaching harmony should follow teaching melody. Whether there is any cause and effect relationship between developmental and teaching orders is unclear. Nye and Nye (1985, pp. 353–377) discuss strategies for developing children's harmonic behaviors extensively.

While this brief sketch of music teachers' views on melodic and harmonic development is limited in scope and depth, it does indicate that the customary teaching sequence basically recognizes and follows the developmental sequence observed by researchers.

Evaluating Melodies and Harmonies

While an examination of the "goodness" of melody or the "appropriateness" of harmony perhaps is more appropriate in a discussion of aesthetics, it also is relevant to the psychological foundations of melodic and harmonic behaviors. The present discussion, however, focuses on "goodness" and "appropriateness" from a perceptual standpoint.

What Is "Good" Melody?

The fundamental problem in determining melodic goodness rests with the relative emphasis one places on its structural and psychological characteristics. If one evaluates only structure, characteristics such as propinquity, repetition, and finality might be important evaluative criteria. On the other hand, explanations in terms of psychological characteristics might concern the extent to which melodies are perceivable as patterns or the degree to which a given melody is representative of a particular style.

Long ago, Mursell (1937, pp. 105–106) argued that all one needed for an authentic melodic experience was "a tonal sequence held together and unified by a unity of response." He maintained that "inferior" melodies lack unity in both structure and response.

After reviewing several accounts, variously treating melody from technical, educational, musicological, and sociological perspectives, among others, Hickman (1976) concluded that order and pattern are essential components of good melodies. He then offered four evaluative criteria: The melody must (a) manifest a pattern of elements, (b) be a product of a person or persons, (c) do more than adhere to specifications previously laid down, and (d) be worth having in itself apart from any purpose it may serve.

Lundin's (1967, pp. 84–85) cultural interpretation of melody considers melody both a function of the listener's previous experience and certain structural characteristics. He maintains that melodies are a result of many centuries of musical development. New patterns were accepted gradually as people became familiar with them.

Sloboda (1985, pp. 52–55) views a melody's goodness in terms of the extent to which it conforms to its underlying grammar. If the melody conforms totally to the structural rules of Western tonal music, the melody is likely to be dull; if the melody excessively violates basic structural rules, it may be unintelligible to listeners. Sloboda's view presupposes that listeners are enculturated in the grammatical rules of Western tonal music.

Smith and Cuddy (1986) examined the effects of repetition and rule familiarity on the "pleasingness" of 20 melodic sequences varying in complexity of contour and harmonic structure. (The more complex the melodic sequence, the more it violated the rules of tonal harmonic structure.) Their data indicated that the more complex the melody's underlying harmonic structure, the *less* pleasing the subjects rated it. Whether such affective responses reflect a measure of perceptual "goodness" may be debatable, but it certainly seems to support Sloboda's contention that as a melody deviates from the basic grammatical structures of tonal harmony, listeners respond to it differently.

Reimer (1989, pp. 133–138), while concerned with musical goodness rather than just melodic goodness, cites two aspects of goodness, *excellence*, which has to do with the syntactic or structural refinement in the music, and *greatness*, which has to do with the level of profundity of the music's expressive content. Reimer bases the two aspects on Leonard Meyer's (1967, pp. 22–41) theories of value and greatness in music, which Chapter 8 discusses. While the *greatness* criterion is more properly discussed under aesthetics, the *excellence* criterion has its roots in the meanings of musical messages an individual receives while listening.

The meaning an individual receives when listening to a melody is a function of the uncertainty reflected in the information present in the melody. The amount of information an individual receives depends on both the melody's structural and cultural redundancy, i.e., the extent to which the melody reflects a particular melodic style and the degree to which the individual is familiar with and has developed expectations within that style. The greater the perceptual redundancy, the combined effect of structural and cultural redundancy, the more likely the melody is meaningful and hence "good" for the individual.[21]

In summary, melodic goodness may vary from individual to individual. A

good melody for kindergarten children differs from what is good for an adolescent. Similarly, a good melody for the musically sophisticated differs from that which is good for an untrained listener. A melody in an unfamiliar style also might lack goodness for any listener. However, the greater the number of individuals who find meaning in a melody, the more it would appear that the melody's "goodness" status should be elevated.

What Is "Acceptable" Harmony?

"Acceptableness" of harmony has received considerably less attention than either melody or music as a whole. The limited attention is related to one of two basic approaches: studies of (a) the age at which children become cognizant of harmony (e.g., Bridges, 1965) and (b) individuals' preferences for harmony of traditional tonal compositions (Long, 1968; Wing, 1961). Wing has a separate test for harmony, whereas Long asks individuals to select the "better" of two musical renditions and tell whether it is better in terms of melody, harmony, or rhythm.

The latter approach is particularly relevant to our discussion because it essentially seeks to assess individuals' preferences in terms of harmonic appropriateness for given examples of Western tonal music in "classical" style. To the extent that an individual's preferences conform to what musically trained judges agree is appropriate, the individual exhibits knowledge of harmonic style for Western music. While one might consider the "agreement with the experts" approach somewhat snobbish, the particular evaluation mode has merit and offers many possibilities for examining views of "acceptable" harmony.

Ultimately, the acceptableness of harmony, just as the goodness of melody, is an individual matter and a function of an individual's experience with harmonic styles. The information theory framework noted in the discussion of melodic goodness also may apply to harmony, and the meaning an individual receives from harmony is related to the expectancies he or she has developed for the given style. Appropriateness of harmony, therefore, also is an individual matter, but the degree to which groups of individuals find given harmonies acceptable reflects a cultural or subcultural acceptance.

Evaluation of Melodic and Harmonic Behaviors

Evaluations of melodic and harmonic behaviors generally involve one or more of several basic behavioral types: (a) behaviors reflecting recognition of tonal patterns, (b) behaviors reflecting discriminations between aurally presented tonal patterns, (c) behaviors associating aural and visual stimuli, and

[21]Of course, the "good" melody may seem trite and boring due to excessive cultural redundancy.

(d) production behaviors. The preference tests mentioned above conceivably could be considered a fifth type. Also, production behaviors possibly could be subdivided into notation and performance behaviors.

Some of the same concerns noted regarding evaluation of rhythmic behaviors also apply to evaluation of melodic and harmonic behaviors. The nature of the response mode selected for measuring discrimination could affect the assessment; group versus individual measurement also is an important consideration, in terms of both accuracy and economy. Failure to perform does not necessarily indicate failure to perceive. Finally, approaches used in some tests reflect *specifics* versus *global* measurement issues. The value of a particular approach ultimately depends on the purpose of the evaluation and the nature of the data sought.

The most commonly used measures of melodic and harmonic behavior involve performance, usually from notation. Performances of both prepared and sightread pieces are used for evaluative purposes from primary school through professional levels. Melodic and harmonic dictation also are much used for evaluative purposes, particularly in high school and college music theory classes. The evaluative criteria for performance usually are in terms of a teacher's or adjudication panel's perceptions of what is "correct" and "artistic" performance. While the pitfalls of this are many, the system apparently works to the satisfaction of many musicians; otherwise, there would be greater demands for refinements in the system.

A number of published music tests exist, and common to many is a *tonal memory* test, of which there are two basic approaches. One presents a model melody or series of tones. In subsequent hearings, which may range from two to six, the testee must indicate *how* the melody was changed, usually from options such as key, rhythm, or pitch of some individual tone. The *Test of Musicality* (Gaston, 1957) and the *Drake Musical Aptitude Tests* (Drake, 1957) used this type of tonal memory test.

The other type of tonal memory test also presents a model, but in subsequent hearings the testee must indicate *which* tone is changed. The number of subsequent hearings varies, usually from two to seven. Tests using this type of tonal memory test included the *Seashore Measures of Musical Talents* (Seashore, Lewis, & Saetveit, 1939, 1960), *Standardised Tests of Musical Intelligence* (Wing, 1961), and *Measures of Musical Abilities* (Bentley, 1966).

Gordon's (1965, 1988) *Musical Aptitude Profile* also measures tonal memory, or imagery, as the test labels it, by presenting a model melody and then a second melody that is either an embellished version of the model or an entirely different melody. This approach appears to assess the respondent's ability to discriminate tonal patterns at different structural levels, since the testee must determine whether the second melody would be like the model if the embellishing tones were not present. The "harmony" portion involves

essentially the same process, with the changes occurring in a bass line. The upper voice remains identical for both the model and second version.

Gordon (1979, 1982) developed three additional tests that include measures of tonal aptitude. The tonal subtest of the *Primary Measures of Music Audiation* is designed to assess the abilities of kindergarten through third-grade children to discriminate between pairs of two- to five-tone aural patterns. One tone in the second of each pair is changed. The *Intermediate Measures of Music Audiation* has a similar test that follows the same format, but is designed for children in grades one through four.

Gordon's (1989) more recent *Advanced Measures of Music Audiation* are designed to assess tonal and rhythmic aptitude of high school and college students. Based on Gordon's concept of "audiation," where a person mentally hears and comprehends musical patterns without immediate aural stimulation, the 30-item measure requires students to decide whether "answers" to musical "questions" are the same as the "questions," differ tonally, or differ rhythmically. Tonal differences may involve changes in individual pitch, mode, tonal center, or combinations thereof. Rhythm changes may include altered duration, meter, tempo, or some combination thereof.

Thackray (1973, 1976) devised several useful measures of tonality and harmonic perception. His tonality test measures tonality in melodies and has four subtests. Part I includes modulations in some melodies and asks respondents to indicate whether the melodies sound "right" or "wrong." Part II uses short unfamiliar melodies, some of which are diatonic and clearly adhere to tonality while others do not, and asks respondents to determine whether each melody is "ordinary" or "peculiar." Part III requires determinations of whether the melodies sound "finished" or "not finished," and Part IV asks whether the melody's concluding tone is the same as the beginning tone. Although the test is not standardized, it appears to be potentially very useful for assessing children's tonality perceptions.

Thackray's harmonic perception test, also not standardized, has three parts. Part I includes a series of sounds played on the piano; some are single tones and some are chords. The respondent indicates which are chords. Part II presents pairs of three- and four-tone harmonized melodies; the respondent indicates which tone (if any) in the second hearing is harmonized differently. Part III presents a chord followed by a pause and then a progression of three, four, or five chords, and the respondent indicates where the given chord appears in the progression.

Colwell's (1969–1970) *Music Achievement Tests* measure various behaviors related to melody and harmony. Some of the measured behaviors include determining (a) whether a pattern or phrase moves scalewise or in leaps, (b) whether chords and phrases are in major or minor mode, (c) whether notated melodies match aurally presented melodies, (d) which among three tones

following a cadence or phrase is the key tone, and (e) the style periods of aurally presented musical excerpts.

The *Iowa Tests of Music Literacy* (Gordon, 1991) measure three aspects of tonal concepts: aural discrimination, aural-visual discrimination, and notational skills. Essentially, the aural discrimination tests (called "Audiation/Listening") measure the ability to discriminate between major and minor tonality and some additional modal patterns. The aural-visual discrimination tests ("Audiation/Reading") ask respondents whether given notated melodies match aurally given melodies, and the notational test items ("Audiation/Writing") are quasi-dictation tasks.

Several aural-visual discrimination tests measure melodic aural-visual discrimination, but they do not provide separate scores for melody and rhythm (e.g., Farnum, 1953; Knuth, 1966). Melodic performance is a major criterion in scoring the *Watkins-Farnum Performance Scale* (Watkins & Farnum, 1954), but neither does it provide a separate melody score.

The same recommendations offered at the conclusion of the rhythm test discussion apply here. Researchers and teachers concerned with selecting and developing measures of melodic and harmonic behaviors should first and foremost consider the nature of the behaviors they wish to evaluate and be certain that any measures selected or developed indeed measure those behaviors in a manner appropriate for the student's level.

Summary

This chapter's major points include the following:

1. The vertical structure of Western music is considerably more highly developed than that of other cultures.
2. Most Western music is constructed within a tonal harmonic framework.
3. Changing either the relative pitch positions of tones or the rhythm of a tonal sequence changes the melody structurally, although not always perceptually.
4. One can define melodies as both structural and psychological entities.
5. Recent accounts of melodic perception are inferred descriptions of the cognitive processes and structures developed from melodic experiences.
6. Model tonal hierarchies are based either explicitly or implicitly on generative grammars, the organizational rules that underlie musical structure.
7. Most models of melodic perception acknowledge the perceptual laws of Gestalt psychology.
8. Harmony in Western music is primarily tertian harmony.
9. The three basic "holistic" attributes of harmony are tonality, harmonic movement, and finality.

10. Melodic and harmonic movement are relative phenomena.
11. Perceptual organization of harmony is context dependent.
12. Tonality is an underlying unifying device in the perception of Western tonal music.
13. The diatonic scale is the basic scale for Western music.
14. Scale systems are codifications of musical practice.
15. The tempered diatonic scale is the most far-reaching standardization of tonal organization in the world.
16. The diatonic scale evolved from the Greek "Greater Perfect System."
17. Equal temperament is the most satisfactory tuning system for Western music.
18. Major and minor scales comprise the basic tonal patterns or modes for most Western music.
19. Other modes include the church modes, the whole-tone scale, pentatonic scale, chromatic scale, quarter-tone scale, synthetic scales, and scales of other cultures.
20. While most music uses fixed pitches in a tonal harmonic framework, some contemporary music uses sliding and indefinite pitches and may have no intended tonality.
21. Hierarchical perceptual models essentially are descriptions of inferred psychological events.
22. Important hierarchical models regarding the perceptual organization of pitch structures include Krumhansl's tonal hierarchy for melodic patterns and Lerdahl and Jackendoff's time-span reduction and prolongation reduction models.
23. Recent research in melodic perception confirms that perception and memory depend on a melody's tonal harmonic framework.
24. Musical meaning is a product of expectations a listener has developed.
25. Expectations are a function of the information a musical example provides.
26. Information increases as uncertainty increases.
27. Information decreases as redundancy increases.
28. Perceptual redundancy is a function of the music's structural characteristics (structural redundancy) and a listener's previous experiences with music of that style (cultural redundancy).
29. Research confirms a general consistency in musicians' expectations regarding melodic continuations for given melodic fragments or contexts.
30. Musical expectancies are hierarchical.
31. Basic receptive behaviors include recognition and discrimination.
32. Basic production behaviors include singing, instrumental performance, and creating music.

33. Children develop melodic behaviors before harmonic behaviors.
34. Music teachers' practices generally reflect the sequence in which melodic and harmonic behaviors develop.
35. A melody's "goodness" and harmony's "acceptableness" in the psychological sense are functions of an individual's previous experience with melodies and harmony in given styles.
36. Evaluation of melodic and harmonic behaviors involves one or more of several behavioral types: (a) recognizing tonal patterns, (b) discriminating between aurally presented tonal patterns, (c) associations between aurally presented and visually presented patterns, and (d) production behaviors.

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in turn facilitate perception of new melodies and harmonies.

Woodruff (1970) calls memories of previous experiences *concepts* (see also Chapter 10) and suggests that they provide the basis for musical behavior. Regelski (1975, p. 11) elaborated on the view that concepts are general thought tendencies and suggests that they result from (a) perception and cognition of many particular personal experiences with the learning or skill to be mastered, (b) the transfer of certain learning from particular personal experiences to other particular but somewhat different situations, and (c) a gradually evolving tendency toward increased frequency of the particular musical behavior.

Expectations, therefore, are basic to conceptualizing music. Musical concepts, recognized as cumulative tendencies toward response resulting from cognitive musical organizations, are the product of memories and classifications of previous experiences with musical stimuli. While musical concepts involve covert cognitive activity, they form the basis for both receptive and production behaviors. Receptive behaviors essentially are perceptual and therefore covert in nature; production behaviors involve musical production or reproduction.

RECEPTIVE BEHAVIORS. Since receptive behaviors are essentially covert, investigators must devise some overt manifestation to study as evidence of reception. This may create additional questions; investigators do not always agree regarding whether particular overt behaviors validly indicate covert perception or conception. For example, tasks that investigators might devise to study melodic perception might range from simple melodic recognition or discrimination to singing or notating an aurally presented melody. Some "melodies" used in research are limited, contrived tonal sequences that may or may not represent Western melodies. While some investigators define their terms operationally and limit their generalizations, others apply vague labels to their studies and sometimes generalize far beyond what the data justify, thereby leaving the reader with excessive, seemingly contradictory information. Intermixing theoretical considerations with presentations and discussions of empirical data may compound the confusion. Unfortunately, no neat and tidy solutions to such problems exist.

One should recognize that receptive behaviors are essentially perceptual and involve *recognition of* and *discrimination between* musical stimuli. Both processes are fundamental to melodic and harmonic reception. While listening to music, an individual, usually without any particular awareness, constantly separates the familiar from the unfamiliar and compares new patterns with memories of previously learned patterns. The better the new melodies and harmonies match the expectations based on memories of previous experiences, the more comprehensible they are.

Fiske's (1990, 1993) theory of music cognition holds that music listening essentially can be reduced to a series of comparisons and decisions. According to the theory, music cognition, a uniquely human form of behavior, involves expending time and effort to identify patterns based on their tonal and rhythmic (T-R) relationships. A pattern may be a given pattern (P), a pattern derived from P (P'), or a distinctly different pattern (Pn). When an individual engages in pattern comparison, which is basic to music cognition, he or she must decide whether the second pattern is (a) identical to the first, (b) a derivation of the first, or (c) distinctly different from the first (Fiske, 1993, p. 2).

Two additional classes of receptive musical behaviors are *analytical* and *aural-visual discrimination*. Essentially, these are extensions of recognition and discrimination, but each goes beyond basic receptive processes. Analytical behaviors reflect efforts to consciously categorize melodic and harmonic patterns into their constituent parts. Aural-visual discrimination involves associating aural stimuli, including melodic and harmonic patterns, with their symbolic (notational) representations.

As may be apparent, receptive behaviors are difficult to isolate entirely from performance behaviors; an element of "performance" exists in any overt manifestation of receptive behaviors. Also, failure to produce does not necessarily mean failure to perceive or receive. A person may be unable to sing because of a vocal production problem rather than a reception or perception problem.

PRODUCTION BEHAVIORS. While Chapter 7 examines some research related to production behaviors, an overview of basic types of production behaviors is included here. They include singing, instrumental performance, and creating music, but most musicians believe that the ability to make musical discriminations underlies all production behaviors. Without the ability to discriminate among pitches and pitch patterns, an individual would be unable to produce his or her musical intentions in any tonal manner. While the present discussion concerns melodic and harmonic production, the principle is the same for all musical aspects, be they dynamics, rhythms, or timbres. If the individual can not discriminate among the tonal attributes, production efforts are hindered.

Each of the three types of production behaviors is subdivided according to whether the behavior is a *re*production or *pro*duction of music. Singing and instrumental performance may involve production of melodies and harmonies not previously produced, i.e., improvisation. In improvisation, the performer combines new melodic and harmonic patterns within a given conceptual framework. Most contemporary improvising, be it by a jazz musician or a church organist, is conceived within a tonal harmonic framework.

Singers and instrumentalists also are involved in the reproduction of melodies and harmonies. They may produce pitch patterns learned "by ear,"

i.e., by rote procedures, and patterns read or memorized from notation. At the risk of overgeneralization, it appears that most music performed in Western cultures, at least in formal settings, involves more reproduction than production.

Creative behaviors also can involve either production or reproduction of musical patterns. A favorite pastime of music theory teachers, melodic and harmonic dictation, requires music students to reproduce in notation aurally given melodic, harmonic, and rhythm patterns. Production of notation, however, involves what some consider the ultimate musical behavior, composition.

Development of Melodic and Harmonic Behaviors

The types of receptive and production behaviors are broad enough to enable division into many sublevels or categories. While a developmental taxonomy of melodic and harmonic behaviors might be feasible, the uniqueness of each child's musical experiences is such that any attempt to set forth such a taxonomy immediately would encounter difficulties. Each child's developmental sequence, while subject to general laws of maturation, is necessarily unique because environment greatly influences musical development (Phillips, 1976; Sergeant & Thatcher, 1974). Nevertheless, some generalizations can be made regarding musical development and this section examines them from two perspectives: research-based studies of musical development and music teachers' views.

Research-Based Findings

Research related to development of melodic and harmonic behaviors primarily is developmental, i.e., studies of children's abilities to accomplish certain musical tasks at various age or developmental levels. A major problem with this approach is the gap between the various musical tasks children are asked to perform and the implications drawn from their performances. Investigators may loosely label many varieties of tasks, including ones requiring musical performance, as melodic perception, even though performance tasks obviously involve production behaviors in addition to receptive behaviors. Loose application of labels to assessment of receptive and productive tasks confounds the study of musical development, and the reader is cautioned to consider the required tasks in any given study and to draw conclusions only with due consideration of the task natures.

Another difficulty in drawing conclusions from studies of young children is the notorious unreliability of measuring instruments. Investigators often draw conclusions on the basis of a very limited sample or responses to tests of questionable reliability and validity. These difficulties, coupled with the

uniqueness of each child's musical experiences, make sweeping generalizations about children's musical development hazardous. Nevertheless, a growing body of research reveals increasing consensus regarding melodic and harmonic development, and some of the more significant studies are noted here.[19]

A series of studies by Trehub and her colleagues (Chang & Trehub, 1977; Trehub, Bull, & Thorpe, 1984; Trehub, Thorpe, & Morrongiello, 1987) indicates melodic response begins in infancy. Chang and Trehub monitored five-month-old babies' "startle" responses to changes in six-tone melodic patterns and observed changes of heart rate (acceleration) when a pattern with a different contour was played after the infants had become habituated to another pattern. However, such response was not evident when contour was maintained but transposed up or down a minor third. The 1984 study (Trehub, Bull, & Thorpe) examined the effects of additional melodic transformations (transpositions to other keys, altering intervals while preserving contour, altering octaves with accompanying contour changes) on six- to 11-month-old infants. Using the "operant head turn procedure" as the response measure, the investigators observed that subjects responded to new melodies or tone sequences as *familiar* if the sequences had the same melodic contour and frequency range as a previously heard sequence, but they responded to sequences with either different contour or range as *novel*. The 1987 study (Trehub, Thorpe, & Morrongiello) tested nine- to 11-month-old infants for their discrimination of changes in melodic contour in the context of variations in key or interval size. Results revealed that infants could detect changes in both variable contexts, lending further support to conclusions from previous studies that infants categorize sound sequences on the basis of global, relational properties such as melodic contour. The investigators noted that the absence of response to differences of key and key-plus-interval conditions suggests that infants encode contour, rather than interval, information. In a summative article, Trehub (1993) notes that infants are sensitive to contour and can discriminate between ascending and descending patterns, but they are insensitive to individual pitches and intervals.

Nearly all research on infants' and young children's development of melodic discrimination reveals an increase in skills with an increase in age; however, various studies do not agree regarding the exact ages at which children develop given skills. According to Hargreaves (1986, pp. 68–69), "vocal play," the precursor of spontaneous song, begins during the first year, suggesting that even six-month-old infants possess the prerequisites of music making: the ability to vocalize, vary, and imitate pitch, and detect changes in

[19]Some of the information regarding development appears in a condensed and general way in Chapter 10.

melodic contour.

Sloboda (1985) observed that the first striking change in overt musical behavior after the first birthday comes at about 18 months of age, when spontaneous song begins. "The main characteristic of spontaneous singing is the use of discrete stable pitches (rather than the microtonal glides of the earlier 'song babbling')" (p. 202). Such singing usually does not include words, leading Sloboda to suggest that musical development at this age occurs along a separate "stream" from speech. Spontaneous singing at this level does not appear to reflect efforts to imitate particular songs, although the singing begins to include short melodic patterns using intervals that approximate the seconds and thirds of tonal music.

Most accounts of children's singing during the latter half of the second year suggest a gradual change toward use of melodic patterns reflecting tonal, or culturally "correct," structures in spontaneous singing. They also note an "emerging ability to select melodic fragments from an increasingly large repertoire [of standard songs], and to match these with increasing accuracy to the components of standard models" (Hargreaves, 1986, p. 72). Apparently, children begin to borrow certain aspects of songs they have heard and assimilate them more and more into their own spontaneous songs.

During the third year, children's spontaneous songs appear to become longer and reflect a definite trend toward use of diatonic scale intervals. Davidson, McKernon, and Gardner (1981, p. 305) suggest that children appear to develop a set of song-related expectations that in essence provide a "song frame" which structures their vocal performances. As Sloboda (1985, p. 204) notes, "by two-and-a-half, the child seems to have assimilated the notions that music is constructed around a small fixed set of pitch intervals, and that repetition of intervallic and rhythmic patterns is a cornerstone of music." However, the child as yet seems to lack any grasp of hierarchical structures governing groups of patterns that might prescribe direction and closure. Sloboda observes that songs of children of this age usually have an "aimless" quality, with little or no sense of "finishing."

Toward the end of the third year, children's singing begins to reflect less spontaneous song and more imitation of songs they hear in their environment. Moog's (1976) extensive study of children's musical development revealed that children in the early phases of this stage are able to imitate melodic contour more easily than they imitate exact pitch. However, during the third and fourth years, many children's capacities to imitate songs develop greatly, to the point that "most children can accurately reproduce the familiar songs and nursery rhymes of their culture by the age of five" (Sloboda, p. 205). Spontaneous song is no longer the predominant song style for the five year old. Apparently, children at about age five become much more concerned with accuracy of imitation, reflecting a general develop-

mental trend toward precision and mastery of detail. Five year olds usually are able to maintain the key of a song much better than four year olds, apparently reflecting some higher order "knowledge" of key and tonal center that most four year olds have not yet developed.

The ability to maintain a key or tonal center is not necessarily the same as the ability to learn a song at a given pitch level. Sergeant and Roche's (1973) study of children's ability to learn to sing songs at specific pitch levels suggests that younger children may focus more on the absolute pitch when learning a melody than do older children. Over a three-week period they taught 36 children (13 three to four year olds, 10 five year olds, and 13 six year olds) to sing three melodies. Each melody was taught on an invariant pitch level. One week after the study's completion, each child's singing of the melodies was recorded. Results revealed an inverse relationship between accuracy of pitch level and accuracy of the melodic pattern. The youngest group sang at the most accurate pitch level, but the oldest group sang the melodic patterns most accurately. The results support the investigators' hypothesis that younger children tend to focus on pitch per se, while with increased age and conceptual development they focus more on the attributes of melodic pattern. Sergeant and Roche suggest that absolute pitch skills could be developed if children were trained on fixed pitch instruments during a critical period, common to all children, before higher-order conceptual thinking transcends their preconceptual pitch perception.

McDonald and Ramsey (1979) sought to replicate Sergeant and Roche's study with American preschool children. Seventy-six two through five year olds were taught to sing four songs of invariant pitch levels in six 30-minute training sessions over a three-week period. Their data partially supported Sergeant and Roche's results: There was a positive relationship between age and conceptualization of melody. However, they did not find the inverse relationship between age and pitch level, perhaps due to using a more stringent scoring system for pitch level than did Sergeant and Roche.

A subsequent study (Ramsey, 1983) examined the effects of age, singing ability, and instrumental experience on three, four, and five-year-olds' perceptions of melody as indicated by song vocalization. Ramsey evaluated five melodic aspects: (a) absolute pitching, (b) melodic rhythm, (c) melodic contour, (d) tonal center, and (e) melodic interval. Her data revealed (a) significant differences in the performance of three, four, and five year olds on melodic rhythm, contour, and interval; (b) high ability singers scored higher than low ability singers on perception of melodic rhythm, contour, and interval as well as tonal center; and (c) instrumental and noninstrumental treatment groups did not differ significantly in perception of the melodic components. Surprisingly, the data yielded no significant age level effects on either absolute pitch or tonal center.

Zimmerman (1971, p. 28) notes that a rapid development of melodic perception marks ages six to eight. Petzold (1966, p. 254) and some other researchers, however, report a leveling effect following third grade, or around age nine.

Taylor (1973) notes marked development of harmonic awareness around age nine, but Thackray (1973) maintains that results of his harmonic perception test provide positive evidence that many children develop a considerable degree of harmonic awareness well before age nine. Bridges' (1965) study of harmonic discrimination ability of children in kindergarten through grade three also suggests a gradual development in harmonic discrimination ability. Moog (1976), however, maintains that his research shows unequivocally that preschool-aged children do not experience any sort of harmony at all. Shuter-Dyson and Gabriel's (1981, pp. 147–149) review of several studies examining children's harmonic discrimination in terms of consonance and dissonance (essentially requiring the selection of which version sounded "better" or "correct" in paired comparisons) revealed great improvement between ages five and 10 in selecting "better" or "correct" versions. Such findings lend support to the view that basic harmonic awareness develops as part of children's enculturation with Western music.

Imberty's (1981, pp. 101–115) comprehensive study of tonality development reveals four age-related stages of tonal enculturation: (a) below age six, a period of perceptual *undifferentiation* regarding cadence; (b) from six and one-half to seven years, a *cadential perspective scheme,* i.e., the child considers a musical phrase without a cadence as unfinished, but makes no clear differentiation among differing cadential movements; (c) around eight years, where the child can differentiate between a perfect cadence and absence of cadence and responds to interrupted cadences less clearly; this stage's primary characteristic is the beginning of *perceptive decentration* which enables the subject "to connect what precedes the cadential formula with the formula itself" (p. 113); and (d) around 10 years, characterized by the establishment of a *relation of order;* the perception of the dominant leads to anticipation of the tonic; *reversibility* is evident in the perception of tonal functions, and the syntactic elements of the musical phrase enable the precedence of order and logical anticipation. Imberty's research with older children did not reveal continued development, leading him to recognize a sort of "ceiling effect" that apparently can not be forced higher. Imberty's ceiling effect for tonality occurs at about the same age level as the plateaus for melodic and rhythmic development observed by Petzold (1966).[20]

In summary, melodic discrimination skills appear in infancy and continue to develop through about age eight, with a critical period for development

[20] In general, musical development beyond a certain age/maturity level requires formal musical training, as Chapter 10 notes.

around ages five or six. Perhaps this critical period is reflected in the child's shift from spontaneous song to imitation of songs heard in the child's cultural environment. Harmonic discrimination skills develop later, with earliest harmonic awareness usually appearing around age five or six and with a marked increase around age nine. Whether the leveling in melodic skills around age nine is due to increased harmonic awareness, however, is subject to conjecture.

Music Teachers' Views

The research-based findings discussed above primarily reflect attempts to study children's melodic and harmonic development as a part of their enculturation process with Western music. As children reach school age, musical development becomes more dependent on formal instructional experiences.

The present discussion examines some commonly used methods that music teachers employ for developing melodic and harmonic behaviors. A general instructional sequence at the various elementary school levels emphasizes rhythm in preschool, kindergarten, and the early primary grades. Melody receives greater attention in grades two through four, and harmony begins receiving greater attention in grades four through six. Nye and Nye (1985, p. 272) note that this is the general order in which children develop musical concepts.

The major musical activities for developing melodic and harmonic behaviors include singing, listening, and playing instruments. Movement sometimes is used to reinforce melodic behavior, but it is used primarily to develop rhythmic behaviors.

Although much musical development occurs outside of school, for most children, school music represents their first formal learning experiences with music. The initial pitch-related concept that teachers try to develop in children is *high* and *low* pitch, or more properly *higher* and *lower* pitch, since pitch is a relative phenomenon.

Aronoff (1969, p. 42) notes that young children should develop behaviors related to melodic direction and shape, which various musical activities—singing, listening, and playing instruments—may help develop and reinforce. Children learn that melodies move up, move down, or repeat tones; once they have directional awareness, children can discriminate and describe how a melody moves—by steps or skips, repeated tones, sequences, etc.

While teachers recognize music reading as a developmental process ranging from following simple line notation to reading standard notation, they do not agree regarding the best way to teach reading. Many music educators maintain that reading is best facilitated through instrumental experiences in which the visual symbols stand for particular sounds and sets of movements.

Others advocate a system to foster *relative* pitch reading within a scale or key. The predominant system of this type is the *movable do* syllables, although some teachers use a number system for the eight major scale tones. A *fixed do* system is used primarily in Europe. After reviewing the advantages and disadvantages of syllables and numbers, Gordon (1971, pp. 100–103) concludes that the *movable do* system is best.

Just as research shows that harmonic behaviors develop later than melodic behaviors, music teachers have determined that teaching harmony should follow teaching melody. Whether there is any cause and effect relationship between developmental and teaching orders is unclear. Nye and Nye (1985, pp. 353–377) discuss strategies for developing children's harmonic behaviors extensively.

While this brief sketch of music teachers' views on melodic and harmonic development is limited in scope and depth, it does indicate that the customary teaching sequence basically recognizes and follows the developmental sequence observed by researchers.

Evaluating Melodies and Harmonies

While an examination of the "goodness" of melody or the "appropriateness" of harmony perhaps is more appropriate in a discussion of aesthetics, it also is relevant to the psychological foundations of melodic and harmonic behaviors. The present discussion, however, focuses on "goodness" and "appropriateness" from a perceptual standpoint.

What Is "Good" Melody?

The fundamental problem in determining melodic goodness rests with the relative emphasis one places on its structural and psychological characteristics. If one evaluates only structure, characteristics such as propinquity, repetition, and finality might be important evaluative criteria. On the other hand, explanations in terms of psychological characteristics might concern the extent to which melodies are perceivable as patterns or the degree to which a given melody is representative of a particular style.

Long ago, Mursell (1937, pp. 105–106) argued that all one needed for an authentic melodic experience was "a tonal sequence held together and unified by a unity of response." He maintained that "inferior" melodies lack unity in both structure and response.

After reviewing several accounts, variously treating melody from technical, educational, musicological, and sociological perspectives, among others, Hickman (1976) concluded that order and pattern are essential components of good melodies. He then offered four evaluative criteria: The melody must (a) manifest a pattern of elements, (b) be a product of a person or persons, (c) do more than adhere to specifications previously laid down, and (d) be worth having in itself apart from any purpose it may serve.

Lundin's (1967, pp. 84–85) cultural interpretation of melody considers melody both a function of the listener's previous experience and certain structural characteristics. He maintains that melodies are a result of many centuries of musical development. New patterns were accepted gradually as people became familiar with them.

Sloboda (1985, pp. 52–55) views a melody's goodness in terms of the extent to which it conforms to its underlying grammar. If the melody conforms totally to the structural rules of Western tonal music, the melody is likely to be dull; if the melody excessively violates basic structural rules, it may be unintelligible to listeners. Sloboda's view presupposes that listeners are enculturated in the grammatical rules of Western tonal music.

Smith and Cuddy (1986) examined the effects of repetition and rule familiarity on the "pleasingness" of 20 melodic sequences varying in complexity of contour and harmonic structure. (The more complex the melodic sequence, the more it violated the rules of tonal harmonic structure.) Their data indicated that the more complex the melody's underlying harmonic structure, the *less* pleasing the subjects rated it. Whether such affective responses reflect a measure of perceptual "goodness" may be debatable, but it certainly seems to support Sloboda's contention that as a melody deviates from the basic grammatical structures of tonal harmony, listeners respond to it differently.

Reimer (1989, pp. 133–138), while concerned with musical goodness rather than just melodic goodness, cites two aspects of goodness, *excellence*, which has to do with the syntactic or structural refinement in the music, and *greatness*, which has to do with the level of profundity of the music's expressive content. Reimer bases the two aspects on Leonard Meyer's (1967, pp. 22–41) theories of value and greatness in music, which Chapter 8 discusses. While the *greatness* criterion is more properly discussed under aesthetics, the *excellence* criterion has its roots in the meanings of musical messages an individual receives while listening.

The meaning an individual receives when listening to a melody is a function of the uncertainty reflected in the information present in the melody. The amount of information an individual receives depends on both the melody's structural and cultural redundancy, i.e., the extent to which the melody reflects a particular melodic style and the degree to which the individual is familiar with and has developed expectations within that style. The greater the perceptual redundancy, the combined effect of structural and cultural redundancy, the more likely the melody is meaningful and hence "good" for the individual.[21]

In summary, melodic goodness may vary from individual to individual. A

good melody for kindergarten children differs from what is good for an adolescent. Similarly, a good melody for the musically sophisticated differs from that which is good for an untrained listener. A melody in an unfamiliar style also might lack goodness for any listener. However, the greater the number of individuals who find meaning in a melody, the more it would appear that the melody's "goodness" status should be elevated.

What Is "Acceptable" Harmony?

"Acceptableness" of harmony has received considerably less attention than either melody or music as a whole. The limited attention is related to one of two basic approaches: studies of (a) the age at which children become cognizant of harmony (e.g., Bridges, 1965) and (b) individuals' preferences for harmony of traditional tonal compositions (Long, 1968; Wing, 1961). Wing has a separate test for harmony, whereas Long asks individuals to select the "better" of two musical renditions and tell whether it is better in terms of melody, harmony, or rhythm.

The latter approach is particularly relevant to our discussion because it essentially seeks to assess individuals' preferences in terms of harmonic appropriateness for given examples of Western tonal music in "classical" style. To the extent that an individual's preferences conform to what musically trained judges agree is appropriate, the individual exhibits knowledge of harmonic style for Western music. While one might consider the "agreement with the experts" approach somewhat snobbish, the particular evaluation mode has merit and offers many possibilities for examining views of "acceptable" harmony.

Ultimately, the acceptableness of harmony, just as the goodness of melody, is an individual matter and a function of an individual's experience with harmonic styles. The information theory framework noted in the discussion of melodic goodness also may apply to harmony, and the meaning an individual receives from harmony is related to the expectancies he or she has developed for the given style. Appropriateness of harmony, therefore, also is an individual matter, but the degree to which groups of individuals find given harmonies acceptable reflects a cultural or subcultural acceptance.

Evaluation of Melodic and Harmonic Behaviors

Evaluations of melodic and harmonic behaviors generally involve one or more of several basic behavioral types: (a) behaviors reflecting recognition of tonal patterns, (b) behaviors reflecting discriminations between aurally presented tonal patterns, (c) behaviors associating aural and visual stimuli, and

[21]Of course, the "good" melody may seem trite and boring due to excessive cultural redundancy.

(d) production behaviors. The preference tests mentioned above conceivably could be considered a fifth type. Also, production behaviors possibly could be subdivided into notation and performance behaviors.

Some of the same concerns noted regarding evaluation of rhythmic behaviors also apply to evaluation of melodic and harmonic behaviors. The nature of the response mode selected for measuring discrimination could affect the assessment; group versus individual measurement also is an important consideration, in terms of both accuracy and economy. Failure to perform does not necessarily indicate failure to perceive. Finally, approaches used in some tests reflect *specifics* versus *global* measurement issues. The value of a particular approach ultimately depends on the purpose of the evaluation and the nature of the data sought.

The most commonly used measures of melodic and harmonic behavior involve performance, usually from notation. Performances of both prepared and sightread pieces are used for evaluative purposes from primary school through professional levels. Melodic and harmonic dictation also are much used for evaluative purposes, particularly in high school and college music theory classes. The evaluative criteria for performance usually are in terms of a teacher's or adjudication panel's perceptions of what is "correct" and "artistic" performance. While the pitfalls of this are many, the system apparently works to the satisfaction of many musicians; otherwise, there would be greater demands for refinements in the system.

A number of published music tests exist, and common to many is a *tonal memory* test, of which there are two basic approaches. One presents a model melody or series of tones. In subsequent hearings, which may range from two to six, the testee must indicate *how* the melody was changed, usually from options such as key, rhythm, or pitch of some individual tone. The *Test of Musicality* (Gaston, 1957) and the *Drake Musical Aptitude Tests* (Drake, 1957) used this type of tonal memory test.

The other type of tonal memory test also presents a model, but in subsequent hearings the testee must indicate *which* tone is changed. The number of subsequent hearings varies, usually from two to seven. Tests using this type of tonal memory test included the *Seashore Measures of Musical Talents* (Seashore, Lewis, & Saetveit, 1939, 1960), *Standardised Tests of Musical Intelligence* (Wing, 1961), and *Measures of Musical Abilities* (Bentley, 1966).

Gordon's (1965, 1988) *Musical Aptitude Profile* also measures tonal memory, or imagery, as the test labels it, by presenting a model melody and then a second melody that is either an embellished version of the model or an entirely different melody. This approach appears to assess the respondent's ability to discriminate tonal patterns at different structural levels, since the testee must determine whether the second melody would be like the model if the embellishing tones were not present. The "harmony" portion involves

essentially the same process, with the changes occurring in a bass line. The upper voice remains identical for both the model and second version.

Gordon (1979, 1982) developed three additional tests that include measures of tonal aptitude. The tonal subtest of the *Primary Measures of Music Audiation* is designed to assess the abilities of kindergarten through third-grade children to discriminate between pairs of two- to five-tone aural patterns. One tone in the second of each pair is changed. The *Intermediate Measures of Music Audiation* has a similar test that follows the same format, but is designed for children in grades one through four.

Gordon's (1989) more recent *Advanced Measures of Music Audiation* are designed to assess tonal and rhythmic aptitude of high school and college students. Based on Gordon's concept of "audiation," where a person mentally hears and comprehends musical patterns without immediate aural stimulation, the 30-item measure requires students to decide whether "answers" to musical "questions" are the same as the "questions," differ tonally, or differ rhythmically. Tonal differences may involve changes in individual pitch, mode, tonal center, or combinations thereof. Rhythm changes may include altered duration, meter, tempo, or some combination thereof.

Thackray (1973, 1976) devised several useful measures of tonality and harmonic perception. His tonality test measures tonality in melodies and has four subtests. Part I includes modulations in some melodies and asks respondents to indicate whether the melodies sound "right" or "wrong." Part II uses short unfamiliar melodies, some of which are diatonic and clearly adhere to tonality while others do not, and asks respondents to determine whether each melody is "ordinary" or "peculiar." Part III requires determinations of whether the melodies sound "finished" or "not finished," and Part IV asks whether the melody's concluding tone is the same as the beginning tone. Although the test is not standardized, it appears to be potentially very useful for assessing children's tonality perceptions.

Thackray's harmonic perception test, also not standardized, has three parts. Part I includes a series of sounds played on the piano; some are single tones and some are chords. The respondent indicates which are chords. Part II presents pairs of three- and four-tone harmonized melodies; the respondent indicates which tone (if any) in the second hearing is harmonized differently. Part III presents a chord followed by a pause and then a progression of three, four, or five chords, and the respondent indicates where the given chord appears in the progression.

Colwell's (1969–1970) *Music Achievement Tests* measure various behaviors related to melody and harmony. Some of the measured behaviors include determining (a) whether a pattern or phrase moves scalewise or in leaps, (b) whether chords and phrases are in major or minor mode, (c) whether notated melodies match aurally presented melodies, (d) which among three tones

following a cadence or phrase is the key tone, and (e) the style periods of aurally presented musical excerpts.

The *Iowa Tests of Music Literacy* (Gordon, 1991) measure three aspects of tonal concepts: aural discrimination, aural-visual discrimination, and notational skills. Essentially, the aural discrimination tests (called "Audiation/Listening") measure the ability to discriminate between major and minor tonality and some additional modal patterns. The aural-visual discrimination tests ("Audiation/Reading") ask respondents whether given notated melodies match aurally given melodies, and the notational test items ("Audiation/Writing") are quasi-dictation tasks.

Several aural-visual discrimination tests measure melodic aural-visual discrimination, but they do not provide separate scores for melody and rhythm (e.g., Farnum, 1953; Knuth, 1966). Melodic performance is a major criterion in scoring the *Watkins-Farnum Performance Scale* (Watkins & Farnum, 1954), but neither does it provide a separate melody score.

The same recommendations offered at the conclusion of the rhythm test discussion apply here. Researchers and teachers concerned with selecting and developing measures of melodic and harmonic behaviors should first and foremost consider the nature of the behaviors they wish to evaluate and be certain that any measures selected or developed indeed measure those behaviors in a manner appropriate for the student's level.

Summary

This chapter's major points include the following:

1. The vertical structure of Western music is considerably more highly developed than that of other cultures.
2. Most Western music is constructed within a tonal harmonic framework.
3. Changing either the relative pitch positions of tones or the rhythm of a tonal sequence changes the melody structurally, although not always perceptually.
4. One can define melodies as both structural and psychological entities.
5. Recent accounts of melodic perception are inferred descriptions of the cognitive processes and structures developed from melodic experiences.
6. Model tonal hierarchies are based either explicitly or implicitly on generative grammars, the organizational rules that underlie musical structure.
7. Most models of melodic perception acknowledge the perceptual laws of Gestalt psychology.
8. Harmony in Western music is primarily tertian harmony.
9. The three basic "holistic" attributes of harmony are tonality, harmonic movement, and finality.

10. Melodic and harmonic movement are relative phenomena.
11. Perceptual organization of harmony is context dependent.
12. Tonality is an underlying unifying device in the perception of Western tonal music.
13. The diatonic scale is the basic scale for Western music.
14. Scale systems are codifications of musical practice.
15. The tempered diatonic scale is the most far-reaching standardization of tonal organization in the world.
16. The diatonic scale evolved from the Greek "Greater Perfect System."
17. Equal temperament is the most satisfactory tuning system for Western music.
18. Major and minor scales comprise the basic tonal patterns or modes for most Western music.
19. Other modes include the church modes, the whole-tone scale, pentatonic scale, chromatic scale, quarter-tone scale, synthetic scales, and scales of other cultures.
20. While most music uses fixed pitches in a tonal harmonic framework, some contemporary music uses sliding and indefinite pitches and may have no intended tonality.
21. Hierarchical perceptual models essentially are descriptions of inferred psychological events.
22. Important hierarchical models regarding the perceptual organization of pitch structures include Krumhansl's tonal hierarchy for melodic patterns and Lerdahl and Jackendoff's time-span reduction and prolongation reduction models.
23. Recent research in melodic perception confirms that perception and memory depend on a melody's tonal harmonic framework.
24. Musical meaning is a product of expectations a listener has developed.
25. Expectations are a function of the information a musical example provides.
26. Information increases as uncertainty increases.
27. Information decreases as redundancy increases.
28. Perceptual redundancy is a function of the music's structural characteristics (structural redundancy) and a listener's previous experiences with music of that style (cultural redundancy).
29. Research confirms a general consistency in musicians' expectations regarding melodic continuations for given melodic fragments or contexts.
30. Musical expectancies are hierarchical.
31. Basic receptive behaviors include recognition and discrimination.
32. Basic production behaviors include singing, instrumental performance, and creating music.

33. Children develop melodic behaviors before harmonic behaviors.
34. Music teachers' practices generally reflect the sequence in which melodic and harmonic behaviors develop.
35. A melody's "goodness" and harmony's "acceptableness" in the psychological sense are functions of an individual's previous experience with melodies and harmony in given styles.
36. Evaluation of melodic and harmonic behaviors involves one or more of several behavioral types: (a) recognizing tonal patterns, (b) discriminating between aurally presented tonal patterns, (c) associations between aurally presented and visually presented patterns, and (d) production behaviors.

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Chapter 7

FOUNDATIONS OF PERFORMANCE, IMPROVISATION, AND COMPOSITION

People have intellectual and emotional listening experiences with music. Listening may have profound aesthetic significance, or be rather trite. Musicologists and psychologists may analyze music in terms of its theoretical construction, both in the sense of traditional music theory and psychological "deep" structures. Casual listeners may relegate music to being a commodity, or part of auditory decor. In an age of sophisticated recording and broadcast technology, it is especially easy for listeners to not consider that someone created and ordered the physical sounds that humans organize into music. While one might argue philosophically that "true" music is contained in a score, which may be realized only imperfectly, or exists in some metaphysical or spiritual state that temporal civilizations may imitate only approximately, the sonic musical experience requires actual creation of sounds.

Much of the world's music, especially in the Western classic tradition, is composed–someone provided the performer with a guide, often with particular expectations regarding the conversion of written symbols to sounds. Composition is a creative act, an essential part of comprehensive music education. Unfortunately, composition may be viewed as a gift unavailable to the ordinary person. Certainly, not everyone is a Mozart or an Andrew Lloyd Webber, but arranging sounds and silences and providing instructions for their realization is not an alien skill.

Many forms of music combine creation with *re*creation as performers improvise the music while they play or sing. Jazz is an obvious example, as are some folk styles. Improvisation proceeds within certain frameworks; it balances creativity with expectations.

Until the 1980s, music psychology traditionally neglected performance; the first two editions of this text (1979 and 1988) were no exception. Palmer (1997) suggests that technological advances and interest from the fields of psychoacoustics, biomechanics, artificial intelligence, computer music, music theory, and music education have led to a recent increase in performance research, partly because the underlying cognitive mechanisms of music performance may not be unique. After initially considering performance in the third edition (1997), the authors present this revised chapter, considering per-

formance as a psychomotor behavior, the quality of performance expertise, performance anxiety, improvisation, and composition.

Performance as Psychomotor Behavior

Educational objectives occasionally are classified and organized hierarchically within three "domains": cognitive, affective, and psychomotor. Cognitive objectives usually require primarily intellectual behaviors, as in solving an equation or writing a novel. Affective objectives usually involve feelings and emotions; as Chapter 8 indicates, the affective response occurs when the stimulus "acts" on the organism. Psychomotor objectives require considerable physical effort; musical performance and athletic skills are obvious examples. Readers who are interested in details of the various taxonomic structures should consult Bloom's (1956) cognitive taxonomy, the affective taxonomy of Krathwohl, Bloom, and Masia (1964), and the psychomotor taxonomies of Simpson (presented in Colwell (1970)) and Harrow (1972). The important point here is that musical performance is a set of psychomotor behaviors in which the brain (or "mind")[1] guides the body in the execution of motor skills.

In examining the motor skills requisite for musical performance, Gabrielsson (1999, pp. 518–519) recognizes four theories. In the *closed-loop theory,* body movements produce sensory information. The brain compares the information with an internal representation of intended movements, checks for discrepancies, and takes appropriate regulatory action. The *open-loop* or *motor program theory* relies not on sensory feedback but on a centralized control of all sequential movements. A hierarchical command structure exists, with abstract commands at higher levels and more specificity at local levels. *Schema theory* invokes abstract representations of motor actions and programs, from which the performer may generate movements appropriate for particular situations. "Recall" schemata manage movement executions; "recognition" schemata evaluate the executions. Rules for schemata employment evolve from practice and feedback. In the *Bernstein approach* (named for Nicolai Bernstein, a Russian physiologist), muscles function in groups as coordinated units. Regardless of the theoretical orientation, movements are not happenstance: Psychomotor behavior entails motor movements in accordance with some form of control.

Practice techniques are important for developing skillful execution of the psychomotor behaviors requisite in musical performance. "How to practice" is a time-honored area of investigation in music psychology. During the

[1]The brain is a physical entity; one could hold a brain removed from a cadaver in one's hands. The mind is a metaphysical construct, a summation of what the brain does (Restak, 1984, p. 201). Neural signals regarding performance emanate from the brain; the performer's decisions regarding what signals to send are a function of the mind.

1930s, Rubin-Rabson conducted numerous studies regarding memorization of piano music. Essentially, she found that the superiority of whole over part learning (i.e., memorizing relatively long sections versus short subsections) varies with the learner and the music (1940a), that "overlearning" (practicing well beyond what is necessary to meet a criterion) is of dubious value (1941a, b), that mental rehearsal[2] may benefit performance when it is incorporated into the practice routine, and that distributed practice over a longer time period is superior to massed practice in a marathon session, although individual differences exist (1937, 1940b).

Coffman (1990) contrasted practice conditions of mental rehearsal (which may be construed as a cognitive enhancement of psychomotor skills), alternating mental and physical rehearsal, strict physical rehearsal, and a control condition in which subjects read about sightreading. The subjects "practiced" under their designated conditions between a pretest and a posttest involving keyboard performance of a simple composition. Comparisons of times required to perform the criterion composition, pitch errors, and rhythm errors showed that (a) subjects who actually played during their practice condition had a significantly shorter performance time than control subjects, (b) strict physical and alternating mental/physical rehearsal resulted in a shorter performance time than mental rehearsal alone, and (c) the combination practice condition was not significantly different from the physical rehearsal alone. Mental rehearsal clearly is no substitute for physical practice. Gabrielsson's (1999, pp. 505–507) review of mental practice also confirms the superiority of physical practice, although mental practice is better than no practice, and may have some benefit for advanced performers.

In an important investigation, Gruson (1988) studied the practice strategies of 43 pianists, ranging from novice to advanced skill levels. The pianists practiced three unfamiliar (and unidentified) compositions–one baroque piece, one contemporary piece, and one sonatina. The particular pieces were assigned to individual pianists in accordance with skill levels. Analyses of differences in practice time allocation among pianists of different skill levels showed significant positive correlations between skill level and repeating sections longer than a measure ($r = .72$), practicing the hands separately ($r = .49$), practicing each assigned composition rather than playing other music or stopping[3] ($r = .40$), making selfguiding statements (as in "better slow down")

[2]Mental rehearsal occasionally is compared humorously to the "think system," featured in Meredith Willson's musical comedy and movie *The Music Man*, where young novice instrumentalists are implored to "think" of Beethoven's "Minuet in G" as an exclusive means of practice, but mentally running over what must be done in a performance is a legitimate technique for an experienced performer.

[3]Continually practicing the assigned music may be considered as "on task behavior" or "time on task"; more colloquially, the relationship suggests a tendency for the advanced pianists to not mosie-moosie around.

($r = .39$), and making overt verbalizations, as in "I made a mistake!" ($r = .37$). Significant negative correlations (all $r = -.31$) existed between skill level and playing wrong tones, incorrect repetition of single tones, and stopping for at least two seconds within a five-second interval. An increase in pianistic skill apparently included an increase in the likelihood of employing longer and more systematic practice strategies and engaging in fewer sporadic stabs at the keyboard and less hesitation and off-task behavior. Gruson found that, in particular, the tendency to practice repeated intact sections increased with pianistic proficiency.

Gruson had some pianists continue to practice the assigned pieces for additional sessions; they generally did not change their practice strategies as they gained increasing familiarity with the music. Despite improvements in performance, the pianists largely maintained their practice routines. Gruson (p. 104) indicates "the most salient finding was the impressive consistency across sections of the importance of a number of variables, particularly repeating sections, as discriminators of different musical levels."

Gabrielsson (1999, p. 509) notes that the best practice techniques are a function of the music's extent, difficulty, and meaning as well as the performer's expertise and suggests that one should organize practice in relation to appropriate structural units (e.g., phrases) that gradually are expanded to larger units (e.g., "A" or "B" sections, expositions), with special attention to transitions between units.

The particular practice techniques that benefit a performer depend on an interaction of the performer's skill, the performer's motivation, the performance medium, and the music. Music educators employ diverse techniques with students, often without any particular research base. Many techniques are a function of underlying aspects of learning and musical development, discussed in Chapter 10. In general, practice should be purposeful rather than happenstance, aimed toward specific musical and technical goals, engaged in regularly, and, for novice performers, under the guidance of an experienced performer. Time is important, but so is how the time is spent. In a broad sense, time spent listening to model performances, studying printed music silently, and relating a particular composition to other examples of the musical style are beneficial, as well as actual psychomotor activity. After all, the mind guides the body in psychomotor behavior.

Performance Expertise

The expert performer exemplifies a person who has "mastered" many skills, all of which he or she may marshal in service of a musical goal. Practice strategies and time allocations are part of the total picture, but expertise involves more than efficient and beneficial practice.

Dreyfus and Dreyfus (1986) identified five stages through which learners in diverse fields pass as they acquire expertise: novice, advanced beginner, competence, proficiency, and expertise. Commenting on the final stage, Trotter (1986, p. 36) notes that "experts don't apply rules, make decisions or solve problems. They do what comes naturally, and it almost always works."

Writing in the context of spatial intelligence, Gardner (1993, pp. 193–195) synthesizes research and commentary regarding the expertise of chess masters. The master has an abstract plan for a game. While chess masters may have a strong visual memory, they do not operate from a concrete picture of the chess board or simply memorize an intricate series of moves. Chess masters mentally can reconstruct a board which they have seen for only a very short time, provided that the chess pieces are arranged in a meaningful way, in accordance with the rules of the game. This arouses a set of patterned movements, based in experience and game contingencies, synthesized into an abstract game plan.

Sloboda and Davidson (1996, pp. 172–173) identify two broad dimensions of performance expertise, technical proficiency and expression. They note that expression, while allowing for originality, is not arbitrary with individual performers. Expressive performance is systematic: Particular expressive devices, such as tempo variation and accent, relate to musical structure. Expression provides listeners with clues regarding musical organization. Expression is stable, in that a given performer can execute approximately the same performance interpretation on different occasions, yet flexible, in that the performer can change expression as he or she feels the occasion requires. A certain degree of "automaticity" characterizes the expert performer's expression: He or she need not be concerned with local details.

Gabrielsson (1999, p. 502) asserts that two major components comprise excellence in musical performance: a thorough understanding of the musical structure and meaning, and complete mastery of all technical aspects necessary for flawless execution. These require a mental representation of the music, a plan for transforming the representation into sound, and adequate practice.

Sloboda (1985, p. 101) presents three general principles of expert performance, related to the execution of *abstract performance plans* for musical compositions. First, the expert is aware of large musical groupings within the composition. Such "groupings" are meaningful combinations of tonal and rhythmic material, grouped in accordance with hierarchical organizational principles. Where relatively inexpert performers give inordinate attention to local aspects of the musical surface structure, expert performers plan and execute in accordance with longer range goals. Second, the expert performer employs flexible unconscious procedures for solving local performance problems; conscious attention is devoted to the longer range plan. Inexpert

performers must give full conscious attention to local problems, such as a difficult technical passage. Third, the expert monitors the performance as it evolves and takes corrective action when necessary to prevent inappropriate deviation from the performance plan: Sloboda likens this to knowing what to listen for more than simply listening. Even the monitoring stage is largely unconscious: A characteristic of highly developed psychomotor behavior is that a person can operate successfully without much conscious feedback. Clearly, the expert musical performer has mastered sufficient detail so that he or she can devote attention to a musical rendition of a large scale work.

The expert performer may be capable of extensive use of well-developed knowledge structures or schemata. Clarke (1988) suggests that generative processes are involved in musical performance, including sightreading, prepared performance, and improvisation. Such processes may include representation of musical structure in an input form to the motor system, as well as the production and control of musical expression. He indicates that the cognitive structures involved in an abstract musical understanding and those involved in execution of a motor sequence in service of performance are hard to distinguish. In turn, those performance-related structures differ for the type of musical task.

The structures involved in playing music from memory theoretically are the most deeply embedded, although only part of them probably are involved at any one time within the performance. Reading relatively unfamiliar music requires coping with uncertainties, regardless of the performer's familiarity with the musical style. Such uncertainties arise from the performer considering different musical projections and combinations of notated patterns, an imperfect and incomplete stylistic knowledge, and musical creativity demanding a departure from stylistic norms. Clarke indicates (p. 6) that fully adequate generative structures require complete information; the performer who must play unfamiliar music has a limited structural representation of that music, one which must undergo continuous modification as the music develops.

With improvisation, the performer's structural representation is usually quite incomplete. The structural hierarchy may be rather ambiguous, and structures may be organized associatively (in a linear way, one musical event leading to another) or by repertoire selection (borrowing fragments from other musical scores and joining them).

In many musical styles, a performance is more than a technically accurate rendition of properly sequenced sounds and silences, important though that aspect is. Musical *expression* is necessary. Clarke believes that the performer derives expression from information found in musical structure, rather than from fixed patterns found in all music. The expressive parameters for pianists are tempo, dynamics, and articulation; performers in other media

may employ additional parameters. Interestingly, expression may be obvious *from* the musical structure, or expression may *clarify* the structure. When the structure is clear and the audience is composed of persons who are experienced in the musical style, the music's expressive characteristics are in response to or refinements of the music's inherent properties. Strong coherent musical structures arouse clear expectations in a knowledgeable audience, and that audience probably will hear unusual expressive features as a type of mistake. However, when the musical structure is weak or obtuse, the performer's expressions may impose a particular structure on the music. In a weak structure, deficient in musical organizational reference points, the audience must accept what the performer does. Music lacking in obvious tonality and formal structure provides the performer with an opportunity to educate the audience and shape their musical understandings through his or her expressive interpretations.[4] The expert performer balances structure and individual expression, as two quotes from Clarke (p. 24) suggest: "Clearly a performer must not contradict the structure to such an extent that the music becomes incomprehensible to a listener, but a performer must also avoid playing music in a trite and obvious way" and "At a more subtle level, an individual interpretation can be regarded as a personally selected patterning of the expressive principles that may persist over a long period of time."

In addition to structure and expression, emotion necessarily is part of performance expertise. As Juslin (2001) indicates, a performer has the intent to communicate particular emotions. He or she does this by employing expressive cues, such as variations in tempo, dynamics, timbral quality, and vibrato, or other properties appropriate to the performance medium. Such cues have validity as indicators and arousers of emotion.

In reporting her study of practice techniques and time allocations, discussed above, Gruson (1988) contrasts performers' differing levels of expertise in terms of contrasting strategies. She states (p. 108) "musical practising [sic] may be viewed as a sequence of transactions from controlled to automatic processing in which larger and larger chunks of musical information are built up from more basic subcomponents." When a beginning student makes a mistake, he or she is likely to repeat the erroneous tone or measure. The piece basically exists as a linear sequence of independent notes, each of which functions as a small segment in a larger work. While the beginner thus builds from the bottom up, the expert builds from the top down: The expert decomposes the music into independent but musically linked, hierarchically organized patterns. The expert performer is more likely to follow an error with repetition of an entire musical structural unit rather than only a nota-

[4]Of course, as Chapter 6 indicates, an audience may reject music which goes too far beyond its musical expectancies before they become sufficiently "educated."

tional unit.

Thus, the expert performer has a considerable array of cognitive, affective, and psychomotor skills which he or she employs in the service of carefully planned musical goals. Expression and structural awareness are critical, and particular performance problems are resolved by following a carefully conceived and executed performance plan. In addition to developing technical skills, the performer needs to develop detailed conceptions of music in the styles which he or she hopes to perform.

While we largely have spoken of expertise in the context of individual performers, particularly pianists, expertise may exist among vocal and instrumental performers in all performance media, within all musical styles, and in large and small ensemble settings as well as among soloists. A conductor must plan for accepting structure and resulting expression contained within a musical score, or deciding how adventurous to get in departing from traditional interpretations of that score. New and unusual scores require new awareness of structure and, possibly, novel interpretation and expression. A soloist within an ensemble must play or sing expressively without departing from the basic structure and timing that holds the ensemble together. Ensemble members in accompanying roles, even violists playing repeated tones, French horn players playing afterbeats, and singers humming a harmonic line under a melody, must fit their sounds into a well executed overall performance plan, conceived with due recognition of musical structure and expression.

Performance Anxiety

One problem afflicting many performers, even highly experienced ones, is anxiety. Anxiety, "a state of acute subjective distress that simultaneously motivates behavior aimed at reducing the distress" (Salmon & Meyer, 1992, p. 15), is an inevitable part of being human. Stressful situations, such as tests, auditions, public performances, and other situations in which a person is exposed to critical evaluation, normally will arouse some anxiety. Excessive anxiety is counterproductive. Test anxiety, a very real phenomenon that students of all ages experience, leads the individual to focus on personal inadequacy and real or imagined consequences (Krohne & Schaffner, 1983). According to Raynor (1981), about 25 percent of students are "failure-threatened," i.e., they are motivated primarily to avoid failure. While clear standards and explanation of the importance of a particular performance may be beneficial for students who are "success-oriented" (how Raynor classifies another 25 percent of students), the "failure-threatened" students' futures should not be linked to a present task. Musical performance is a type of "test," so concerns for test anxiety and individuals motivated mainly by

avoiding failure are related intimately.

Symptoms of performance anxiety may be physiological, as in urinary urgency, perspiring palms, dry mouth, excessive tension, and rapid pulse; cognitive, basically worrying about potential shortcomings; and behavioral, as in a quivering voice and trembling hands (Gabrielsson, 1999, pp. 569–570).

Steptoe (2001, p. 295) views performance anxiety as a *situational stress response,* similar to some fears of social situations and academic examinations: Performance anxiety is not unique to performing music in front of an audience. Steptoe identifies four components of performance anxiety: *affect* (feeling anxious, tense, apprehensive, or panicky), *cognition* (losing concentration, failure to remember, distraction, reading errors, thinking of what could go wrong), *behavior* (shaking, difficulty in moving, breakdowns in performance technique), and *physiology* (trouble breathing, lack of salivation, accelerated heart rate, gastrointestinal problems, excessive release of cortisol and adrenaline).

While definitions and descriptions of performance anxiety usually relate to the performance task at hand, anxiety also is a function of various conditions occurring well before performance time. Taking this into account, LeBlanc (1994) developed an 11-level hierarchical model of sources of variation in music performance anxiety. Organized across time from planning for a public performance to receiving feedback following it, the model categorizes sources contributing to anxiety that arise from within the performer and from circumstances surrounding him or her. We briefly summarize each level here.

The beginning level of the hierarchy, numbered eleven (LeBlanc numbers the levels inversely), includes certain personal characteristics and experiences of the performer. Among these are age, musical ability, musical training, personality, amount and quality of performing experience, memory, and circadian rhythm. LeBlanc notes that adolescent performers may be especially vulnerable to anxiety, as are people who are basically pessimists, that musical ability and experience facilitate easing anxiety, and that, when possible, performers should perform at the time of day when they feel their best.

The difficulty and appropriateness of the music for performance comprise the tenth level. Obviously, some music is more difficult to play or sing than other music, and music that is appropriate for one performance situation may be quite inappropriate for another. Excessive difficulty and impropriety abet anxiety.

The ninth level of LeBlanc's hierarchy involves adequacy of the musical instrument (or voice) for the performance task, adequacy of preparation to perform, and adequacy of physical conditioning. An inadequate string or reed, fatigue, and just plain lack of practice contribute to anxiety.

The performer's emotional and physical health constitute the eighth level; performing under conditions of emotional or physical duress certainly can increase anxiety.

LeBlanc's seventh level is the performer's current affective state or mood. Regardless of what has happened or has not happened previously, when it is almost time to play or sing, the performer may be happy, sad, pensive, exhilarated, frightened, or in some other mood state. The music will have its emotional demands, which may or may not be congruent with the performer's current mood.

Variables of the performing environment comprise the sixth level. LeBlanc notes measurement devices and procedures (these could include microphones, cameras, and adjudication procedures), physical comfort, whether one is required to perform from memory, distractions, and time of day. In addition, LeBlanc stresses the importance of the presence and behavior of the audience, authority figures (such as adjudicators), educators, family members (who may be supportive or overly critical), the media, and peers (such as fellow students or fellow professionals). Anxiety varies as a function of who one performs before and the environment in which the performance occurs.

The fifth level is one of self-perceptions immediately prior to the performance. Regardless of what actually is occurring, has occurred, or may occur, the performer has beliefs about various conditions, including the music's difficulty and appropriateness, how adequately he or she is prepared, personal appearance, amount of individual exposure (a solo passage draws attention), the performance's importance, and how supportive the audience is.

Arousal, physical and psychological, comprises the fourth level. As the performance is ready to begin, biological and cognitive processes are underway.

The actual performance begins at the third level; all of the previous levels represent prior points in time. LeBlanc indicates that this level is a focus of attention; presumably, the more the performer focuses on the performance itself, the less he or she will focus on anxiety-producing aspects.

The second level involves the self-perceptions of the fifth level during the performance. The performer receives immediate feedback through his or her own ears and may be encouraged or discouraged by the sound.

LeBlanc's first level includes subsequent feedback, as in audience comments, reviews, teacher evaluations, and performance ratings. Favorable feedback may alleviate anxiety in future performances.

LeBlanc's levels include ample opportunities for preparation and anticipation. What the performer thinks might occur may be anxiety-producing, especially in situations where he or she has relatively little control over plan-

ning and execution. What if the music, selected by a teacher or conductor, is too difficult, lacking in interest, or too alien for the intended audience? What if the performer planned the performance with an overly optimistic view of his or her abilities? What if a particular someone is (or is not) in the audience? What if carefully rehearsed executions go awry? What if? What if? Focus on something other than the "music" of a musical performance seems to be a major cause of excessive performance anxiety. Wolverton and Salmon (1991) note that high-anxiety performers focus more on themselves and less on the music than low-anxiety performers. Motivation for audience approval is greater than motivation arising from the music itself among highly anxious performers.

Thinking of everything that could go wrong in a performance certainly is anxiety-producing, but adequate physical and mental preparation with an awareness of likely contingencies may counteract negative concerns. Salmon and Meyer (1992) discuss comprehensively preparing for performance and alleviating anxiety. Much of the following discussion is based on their work, which readers especially interested in performance anxiety are encouraged to read in detail.

As discussed frequently in this text, music has many social functions, and one can divorce social aspects from musical aspects only with difficulty. Indeed, as Davidson (1997) documents, social aspects of performance, including the presence of others and performance etiquette (such as acknowledging applause and abiding by explicit or implicit dress codes), are inevitable in any live performance. Many young performers are accustomed to receiving praise from parents, friends, and teachers in exchange for their public performances; they grow to link their self-esteem to other people's reactions to their efforts. Praise and positive reinforcement are important in nurturing musical learning, but some teachers, quick to praise even mundane things such as opening a music book to the right page, overdo it and thereby "protect" students' self-esteem in an unhealthy way. Thus, for many young performers, motivation is largely extrinsic. With maturity, motivation becomes more intrinsic, but there still is a connection with reactions of other persons, including teachers, audition committees, critics, and audience members. Excessive focus on what others may think may induce stress as a performance is anticipated as well as while it is presented. Salmon and Meyer indicate (p. 25) "stress has more to do with how you evaluate and react to events than it does to the events themselves."

Many therapeutic aids for anxiety and stress exist; in extreme cases, pharmacological treatments are available, in accordance with a physician's guidance. Certainly, the promising performer who experiences debilitating episodes of stage fright or can not prepare adequately for performance because of associated anxiety should seek assistance. Yet, much of what is

involved in coping with anxiety comes down to a sense of personal control, coupled with adequate planning. The performer should imagine a successful performance; practice sessions should involve more than learning music– they should include anticipation of feelings. Some anxiety is to be expected. Performer preparation includes selection of music, actively learning it, and the important few days and hours before the performance, when a wise performer may occupy time by engaging in activities over which he or she has considerable control. Physical manifestations of anxiety, such as accelerated heart rate and perspiration, will occur–they are normal and may be anticipated as such. Criticism of a performance will occur–yet the performer should be his or her own worst critic. There is no substitute for practice, but practice encompasses all phases of preparation, not only "learning the notes."

A belief that a little anxiety is a good thing may grow from a demonstrated curvilinear relationship between motivation and measures of efficiency: As motivation increases, performance efficiency increases to a certain point; after that, further increases in motivation lead to a decrement in performance (Atkinson, 1983). Yet, the inverted-U relationship between performance quality and arousal may not always occur. Arousal may disturb some musicians but facilitate a good performance in others. Physiological arousal is less central to performance anxiety than an interplay between cognitive processes and physiological activation (Steptoe, 2001, p. 292). While one can not pretend that an event which is important for one's career and musical advancement is trivial, one still may reflect on just what any individual performance means in life. Motivation to do one's best while recognizing that life is filled with diverse opportunities may be a healthy condition in approaching performance.

In discussing preparation for auditions, which may be quite stressful and critical for performers' professional advancement, Dunkel (1989) notes that the audition process is filled with risks to a person's self-esteem; again, separation of the social from the purely musical is difficult. The risk taken by undergoing a rigorous audition may be devastating, *but* it may build further esteem. Dunkel comments (p. 4) on the inevitable competitive aspect:

> All forms of competition are hostile. They may seem friendly on the surface but the prime motivation is to be or do "better than" anyone else. Although it may appear that the world is a competitive place, it is only competitive to those who feel the need to compete.

So, the person who elects to enter the competitive world of professional performance with its demands for expertise must accept the anxiety and stress that accompany it. Dunkel presents a potpourri of advice, to which the inter-

ested reader is referred. Basically, one should focus carefully on goals, separate one's self from one's performance, and yet maintain a close relationship with the music.

Improvisation

Historical Perspective

Musical performance may involve performances of (a) particular compositions, which may be learned either by rote and performed from memory or learned from notation and performed either from memory or from notation, or (b) improvisations, which involve extemporaneous performance of newly created music. Historically, improvisation and composition were more closely related than they are today. Many great composers were excellent improvisers, e.g., Bach, Handel, Mozart, Beethoven, and Schubert. Performances from the baroque figured-bass tradition were essentially improvisations, allowing the performer to create music extemporaneously, but within the context of the tonal harmonic framework suggested by the figured bass.

Many compositions, particularly from the baroque era, are called "improvisations," the intent being for the performer to embellish upon the provided melodic, harmonic, and rhythmic structures. The embellishments, which usually reflect the performer's musical expertise and technical virtuosity, constitute the improvisatory aspect of the musical rendition.

Pressing (1984a) indicates that improvisation in Western music had its roots in early monophonic vocal music, which during the first millennium was "primarily a mixture of Greek, Arabic, Jewish, Oriental, and Christian influences" (p. 65). Through exposure to oral traditions, performers had ample opportunity for creative musical renditions. Pressing notes that improvisation certainly was important in solo passages, and perhaps even in choral passages. Melismatic flourishes in certain alleluias of early Christian liturgy were continuations of the improvisatory practices of early vocal music. With the beginning of *organum* came improvised polyphony, and *melismatic organum*, involving singing florid passages above the plainsong chant, began in about the twelfth century (Pressing, 1984a, p. 65). As organum became passé)¿ around the middle of the thirteenth century, the *motet* with its *cantus firmus* became a predominant form. The other parts of motets were either improvised, composed, or embellishments of composed parts. In the fifteenth century, *faburden* allowed singers to improvise over a *cantus firmus*, using a system of "sights" in which each improvising singer read the cantus firmus but added a new part above or below the melody. Pressing notes that thirds and sixths above the bass were the preferred intervals, except at the beginnings and endings of phrases, where octaves and fifths

were preferred. Slightly later, *fauxbourdon* developed, and here the outer voices usually were notated, but singers improvised the inner voices.[5]

With early renaissance developments in instrumental music, particularly for keyboard instruments such as the clavichord and harpsichord, came the development of *intablatures,* relatively plain transcriptions of vocal music, which seemed to serve as frameworks for improvisations on the keyboard instruments. By the beginning of the sixteenth century, there was a virtual explosion of improvisatory techniques and treatises about improvisation, which was considered a required skill for performers of the time. The four main improvisation procedures found in the sixteenth century involved "ornamentation of a given line, addition of one or more contrapuntal parts to a cantus firmus (including imitation based on given or invented motives), themes and variations, and free improvisations" (Pressing, 1984a, p. 67). Improvisation's importance continued to develop and reached its peak in Western art music during the baroque era; however, the baroque also saw the beginning of the decline of improvisation in Western art music.

While embellishments and variations on composed melodies continued to be important during the baroque, keyboardists' realizations of a *figured bass* became the predominant mode of baroque improvisation (Pressing, 1984b, p. 60). "The *cadenza* was the last distinctive [improvisational] device pertinent to the Baroque" (1984b, p. 66), and it remains a continuing part of solo performance today. However, "the traditions of improvisation dramatically declined into virtual extinction" (1984b, p. 66) during the classical and romantic eras. Many reasons exist for the decline of improvisation in Western classical music; Pressing (1984b, p. 66) suggests that the change of emphasis to composed music perhaps reflected the "*Zeitgeist* of scientific method, economic centralization, rationality, and the upsurge of machinery technology." He also notes that the rise of musical amateurism with performers who lacked improvisatory skills increased the demand for composed rather than improvised music. Western classical music since the baroque predominantly has been composed music.

Improvisation remains an important aspect of the Western church organ playing tradition. While much of an organist's improvisation is functional, i.e., to accommodate the uncertain timing of particular parts of the ritual and to provide bridges between various musical portions of the service, improvisational skill constitutes an important part of the church organist's repertoire of performance skills.

[5]Pressing (and hence the present text) differentiates between "faburden" and "fauxbourdon." The terms fauxbourdon (French), faburden (middle English), falso bordone (Italian), and fabordone (Spanish) occasionally are used interchangeably. According to Apel (1944, pp. 259–261), fauxbourdon properly designates the fifteenth-century notated outer voices/improvised inner voices technique described here. More generally, it denotes a style of parallel-sixth chords, with fourteenth-century English origins. Consequently, the text notes fauxbourdon as "slightly later" than faburden.

Today, however, most people associate improvisation with jazz. To be a jazz musician, one *must* be able to improvise: One can not demonstrate true expertise in jazz performance unless he or she can demonstrate expertise in improvisation. Of course, improvisation is not the sole property of jazz musicians; many pop and folk performances include improvisations. Music educators consider improvisation (and composition) as important modes for "knowing music" (Stubley, 1992, p. 13). National standards for music education in the United States[6] include the development of improvisational and compositional skills as two of the nine broad *content standards* for elementary and secondary school music (Consortium of National Arts Education Associations, 1994).

Obviously, improvisational skills, just as other musical skills, may be manifest in various ways and at many different levels. Whether all seemingly extemporaneous music performances are actually improvisations is not clear; it simply may be a matter of how one defines improvisation.

Apel's (1944, p. 351) nearly 60-year-old definition of improvisation as "the art of performing music as an immediate reproduction of simultaneous mental processes, that is, without the aid of manuscript, sketches, or memory" is a good starting point and is particularly apropos for contemporary music psychologists concerned with understanding the underpinnings of musical improvisation. Apel's definition calls attention to the importance of the cognitive processes underlying overt performance behaviors. High level performance skill alone does not necessarily enable one to be a high level improviser. *Performance expertise does not ensure expertise as an improviser, but expertise as an improviser requires expertise as a performer.*[7]

True improvisations are not rehearsed. People who "prepare" improvisations by creating, revising (in some cases writing them out), memorizing, and then performing a given set of patterns for a piece really are engaged in something more akin to composition than improvisation, even thought the "composition" may never be notated. Pieces learned by rote or by ear and performed from memory do not meet Apel's criteria for improvisation. True improvisers do not have the luxury of rehearsing their improvisations. As Sloboda (1985, p. 138) notes, an improviser's *first* idea must work.

Psychological Perspective

Obviously, improvisation, particularly any beyond the simplest levels, involves creative thinking about the organization and structure of the musi-

[6]Such "standards" are the creation of professional organizations; they have no official or legal status.

[7]Readers should not infer that performance expertise necessarily requires expertise in music reading; many expert performers either improvise their performances or learn their music by rote, i.e., through use of imitation procedures and concomitant trial and error procedures.

cal performance. Even people who appear to play by ear or improvise "naturally" have engaged in extended learning, albeit in most cases informally through an enculturation process. Indeed, good improvisers *learn* to improvise, but except for jazz musicians and organists, relatively few musicians understand much about the processes involved in improvisation or how to go about learning to improvise.

Pressing (1988, p. 130) notes that improvisation, as all music performance, involves a continuing series of highly complex instantaneous neurological processes, including (a) passing complex electrochemical signals among the nervous, endocrine, and muscle systems; (b) execution of complex physical actions; (c) rapid monitoring of the actions via visual, tactile, and proprioceptive feedback systems; (d) producing musical sounds and monitoring them via auditory feedback; (e) cognitive evaluations of these sounds as music; and (f) further cognitive processing to generate the design of the next action sequence and trigger it. Pressing notes that the last two steps are more critical to the improviser than to musicians performing specific composed works and observes that the given steps "are often collapsed into a three-component information-processing model of human behavior which has ready physiological analogies: input (sense organs), processing and decision-making (central nervous system . . .), and motor output (muscle systems and glands)" (p. 130). An examination of motor control system complexities is far beyond the scope of the present discussion, and readers are encouraged to examine Pressing's succinct and highly readable account of the system and how it facilitates error correction and motor refinement.

Based on his examination of the model and motor control system, Pressing speculates that skilled improvisers develop through practice "general patterns of neural connections specific to improvised motor control" (p. 131) and notes that these are akin to "motor action units, which may be combined into long chains to develop more complex movements" (p. 131). In summary, skilled improvisers develop a "repertoire" of neurological connections that may be triggered during the improvisational process. Because processing the connections is so rapid, the improviser's performance may appear to be "automatic" or "natural." The major differences among expert, not-so-expert, and non-skilled improvisers appears to be, at least from a psychoneurological perspective, (a) the extent of the repertoire of general patterns of neural connections specific to improvisation motor control and (b) ability to call them into action automatically. Individuals who must consciously think out subsequent steps in their improvisations obviously lack the fluency, fluidity, and flexibility of expert improvisers.

Concomitant with development of the repertoire of general patterns specific to motor control is development of the movement patterns for overt realization of the improvisation. Psychomotor behaviors depend on both

cognitive processing and motor skills. The development of performanc skills is essential for improvisers; they must have sufficient performance ski to do what they wish to do musically in their improvisations. To the exten that performance skills are inadequate, the quality of the improvisation regardless of the sophistication of the musical idea, is undermined Therefore, development of performance skills remains important fo improvisation.

Sloboda (1985) and his colleagues (Sloboda, 1988) have taken the lead i examining the psychological underpinnings of improvisation and composition, and much of the material in this and the following section is drawn fron their insightful work. Following Sloboda's (1985) lead, the balance of this section focuses on the most visible type of improvisation, the one that has developed into the art par excellence for improvisation: jazz improvisation.[8]

Jazz Improvisation

Many music stores and music libraries abound in books and methods fo potential jazz musicians regarding "how to improvise," and interest in suc materials is high. This discussion will not examine such sources; person interested in lists or reviews of such materials should consult one of severa excellent overviews (Doerschuk, 1984; Greennagel, 1994; Pressing, 1988). Doerschuk notes that a survey of extant literature might suggest that improvisation skill can be realized by memorizing scales, modes, and exercises, but he questions this, noting that such systems reflect only a limited perspective on improvisation. Doerschuk recommends that persons interested in a method for learning improvisation examine the work of Emile Jaques-Dalcroze, whose tripartite approach to musicianship involved eurhythmics, solfege, and music improvisation.

Greennagel reviews both methods and research on improvisation and concludes that "most jazz improvisation methods are based on a traditional theoretical approach with variations appearing in terms of suggested listening, drill, or writing exercises, or in combination with play-along practice" (1994, p. 35). He notes, however, that the approaches of Liebman (1988) and Sudnow (1978) focus much more on improvisation's creative aspects than other approaches. Greennagel's review revealed that most research on jazz improvisation is of the "methods development" variety.

Pressing's (1988) review suggests that approaches to teaching jazz improvisation appear to reflect one or more of five broad perspectives: (a) the historical view that improvisation essentially is the equivalent of real-time composition; (b) the view that improvisation involves the establishment of pat-

[8]Apologies are extended to organists, for whom improvisation is an important and necessary tool.

terns, models, and procedures specific to the improvisational situation, "which, if followed by those possessing a solid enough level of musicianship, will produce stylistically appropriate music" (p. 142); (c) the view that improvisation is best developed by setting a series of improvisational problems or constraints as in the Jaques-Dalcroze approach; (d) the view that improvisation involves the "presentation of multiple versions of important entities by the teacher . . ., leaving the student to infer completely on his or her own the ways in which improvisation or variation may occur by an appreciation of the 'fuzziness' of the musical concept," (p. 143) which Pressing labels an "imitative, self-discovery approach"; and (e) the view that creative musical performance is "allied to the self-realization ideas of humanistic psychology" (p. 144).

Based on his comprehensive review of the history, theory, and approaches to improvisation, Pressing offers a cognitive model of improvisation. He argues that such a model should explain "how people improvise; how people learn improvisational skill; and the origin of novel behaviour" (1988, p. 152). Pressing summarizes the central features of his model as follows:

> It is reductionist, in that cognitive structures of processing and control are considered to be broken down into aspects (acoustic, musical, movements, etc.), each of these into types of analytical representation (objects, features, processes), and each of these into characterizing elements (array components). At the same time the model is synergistic and capable of behavioural novelty, due to the extensive redundancy of the cognitive representations and the distributed and non-linear character of the outlined control processes. The extensive presence of feedback and feedforward contribute to this. The fundamental nature of the improvisation process is considered to be the stringing together of a series of "event clusters" during each of which a continuation is chosen, based upon either the continuing of some existing stream of musical development (called here an event-cluster class) by association of array entries, or the interruption of that stream by the choosing of a new set of array entries that act as constraints in the generation of a new stream (new event-cluster class). (Pressing, 1988, p. 168)

While Pressing's complex and insightful model needs to be studied, understood, and examined empirically, it undoubtedly will be refined before it is accepted as "truth" by all who are interested in understanding the nature of the psychological processes underlying improvisation.

Meanwhile, Sloboda's (1985) characterization of some of the attributes of the jazz improvisation process may be useful. What seems to make improvisation manageable for jazz musicians is the fact that their improvisation occurs within a large set of formal constraints which provide the blueprint or skeleton for improvisation. The jazz improviser "uses a model which is, in

most cases, externally supplied by culture, and which he embellishes and 'fills in' in various ways" (p. 139). Sloboda notes, for example, that jazz ensemble pieces often have a fairly invariant "chorus" played by the group in alternation with solo sections in which various individuals may improvise for a more or less fixed number of measures until the next chorus. The soloist must be knowledgeable of the underlying structure and how to get from his or her musical excursions back to the next chorus in a novel and musical way (Sloboda, p. 141).

In discussing the 12-bar blues and 32-bar song forms, Sloboda notes that the melody often is a "standard" initially played in a fairly straightforward manner and that the subsequent improvisations usually retain the basic harmonic sequence, but the "*essence* of improvisation, both here [32-bar song] and in the 12-bar blues, is in the melodic line" (p. 143). Sloboda notes that jazz solo performance is necessarily melodic and that jazz piano came later, with the left hand providing rhythm and chords and the right hand "playing the solo."

What makes an improvisation a *jazz* improvisation is the musical vocabulary a performer draws on for the improvisation–the types of melodic, rhythmic, and harmonic devices used to build larger sequences. This vocabulary, however, is not just a memorized set of scale, chord, and rhythmic patterns. It is developed "through listening intently to other musicians and performing with them" (Sloboda, p. 143). Sloboda maintains that books and notation are not really necessary and notes that "many great jazz performers could not read a note of music" (p. 143).

Evaluating Improvisation

The mention of "great" jazz performers immediately begs the questions, "What makes a jazz performance 'great'?" And, more specific to the present discussion, "How does one evaluate the quality of an improvisation?" This discussion purposely will avoid the first question because the variables that may influence judgments of greatness are many, complex, highly subjective, and often go beyond an assessment of the performance per se. For example, the "halo" effect regarding who is performing influences many people's judgments about the quality of the performance, improvised or otherwise. Attempts to evaluate the quality of an improvisation also are fraught with many problems, but several researchers have sought to develop criteria or guidelines for making such judgments more objective. To the extent that different judges agree in their assessments of an improvisation's quality, the inevitable subjective component is minimized.

Potter (1990, p. 69) notes that "many factors may contribute toward making an improvised solo 'good' or 'great,'" and these factors often are diverse

and even contradictory. Solos may be valued for their technical virtuosity, beautiful tone quality, rhythmic characteristics, novelty, restraint and classical balance, use of quotations, and even "expressive use of growls, honks, squeaks, and split tones" (p. 69). While Potter is most concerned with analyses of improvisations, his recommendation that analyses of improvised jazz "be eclectic, holistic, using whatever approaches help explain the solo's effectiveness" (p. 69) holds implications for evaluation of improvisations.

Partchey's (1973) carefully controlled study of children's improvisations offers insights both into strategies for evaluating the quality of improvisations and for developing improvisational skills. Specifically, the study sought to develop a valid and reliable method of evaluating improvisation and to compare the effects of feedback, models, and repetition (i.e., trial and error) on the ability to improvise melodies. Partchey divided 86 sixth-grade children into three treatment groups and gave each child three individual sessions in which to practice respectively improvising blues, whole-tone, and diatonic melodies with given taped accompaniments for each. Pre- and posttreatment evaluations involved pentatonic improvisations. Children in the feedback group heard immediate recordings of their efforts, the models group heard several examples of prerecorded melodic improvisations, and the repetition group received no specific instructions. Children performed their improvisations on an alto-tenor xylophone, with specific pitch bars arranged for the particular scale designated for use in the improvisation. Improvisations were evaluated on a nine-point scale according to two performance criteria (pulse accuracy and rhythmic clarity) and three creative criteria (tonal variety, rhythmic variety, and unity (with subcategories of repetition, imitation, pitch direction, and phrasing)). Interjudge reliability for improvisation evaluations using Partchey's criteria ranged from .92 to .95. Each group showed significant pre-post gains; the feedback group's gains were significantly higher than those of the other two groups. Pre-post changes for creative criteria were statistically significant for the feedback and models group, but pre-post changes for performance criteria were not.

Greennagel's (1994) study of predictors of jazz vocal improvisation skill required developing an appropriate evaluation tool. His basic evaluative criteria, musicality and technical appropriateness, somewhat paralleled Partchey's two broad categories, but he added two criteria specifically appropriate for evaluating vocal improvisations over 12-bar blues choruses. Musicality refers to "how well the improvisation succeeds in making a musical statement" (p. 40), and technical appropriateness refers to "how well the improvisation fits the chord changes and anticipates those changes; also time feel" (p. 40). The additional criteria, articulation and relationship to blues, refer respectively to the use of "vowel and consonant articulation to verbalize intended sounds," and "how well the improvisation fits the traditional

structure of the Blues" (pp. 40–41). Greennagel's criteria suggest that evaluative criteria must be appropriate to the type, style, and general nature of the improvisation. The interjudge reliability coefficient for experienced jazz musicians using Greennagel's criteria was .86.

The high interjudge reliability coefficients for Partchey's and Greennagel's evaluative tools suggest that it is possible to obtain highly reliable evaluations of improvisations in relation to particular criteria. Evaluating improvisations clearly involves more than just a subjective like-dislike response.

Improvisation as a Teaching Tool

In recent years, music educators have become less concerned with assessing the quality of individual improvisations and more concerned with improvisation as a group or collaborative experience. As Sawyer (1999, p. 193) states, "the group collaborations of improvisation can potentially make it beneficial in a wide range of skills, not only musical skills, but social skills like collaboration, group problem-solving, and collective creativity." Essentially, Sawyer considers group improvisation experiences analogous to "conversations," which he views as having three basic characteristics: (a) unpredictability and collaboration, (b) use of structures, and (c) generation of a product. He suggests that musical improvisations, theatre improvisations, and everyday conversations reflect these characteristics; furthermore, he maintains that both adults' and children's group musical improvisations apply these characteristics in similar manners. Sawyer then suggests, and several of his colleagues (Baily, 1999; Hargreaves, 1999; Welch, 1999) concur, that improvisatory experiences have the potential to enhance children's social skills.

> Musical improvisation—because of its parallel with everyday conversation—can teach children how to engage in collective social action. It could teach them collaborative abilities; it could help them to solve problems in group settings, or to brainstorm with others to come up with a creative group innovation. It could teach them how to co-ordinate their own creations and insights with the constraints and limitations of the evolving social world. (Sawyer, 1999, p. 203)

Obviously, not all music educators will agree that social experiences should be the primary goal of children's improvisatory experiences, but music educators' interest in exploring children's musical improvisations has surged (e.g., Brophy, 1999; Burnard, 1999; Guilbault, 1999). The focus, however, appears to be primarily on improvisation as a mode for musical learning, and as Brophy (1999, p. 77) states, it should be *process-oriented* rather than *product-oriented*. Much of the existing research focuses on improvisation at different developmental levels and on various factors that may influence chil-

dren's group and individual improvisations. Whatever the goals, music educators increasingly are advocating that group improvisatory experience become a part of children's music education curriculum.

Composition

Sloboda (1985, p. 103) suggests that "composition is the least studied and least well understood of all musical processes and [notes that] . . . there is no substantial psychological literature to review." Nevertheless, most college, conservatory, and university music departments teach composition, and an examination of generative processes related to composition may be relevant to persons involved in such teaching.

While improvisation and composition have many commonalities, the differences in the two processes warrant separate discussions. As Sloboda (1985, p. 103) notes, the "constraints of improvisation–immediacy and fluency–make it likely that there are processes which improvisation and composition do not share." He is particularly concerned with two aspects of psychological activity that seem to be a part of the generative process of composition: "the occurrence of superordinate structures or plans which seem to guide and determine the detailed note-by-note working out . . . [and] the degree to which these plans can . . . be rather provisional. They can, for instance, be changed in light of the way a particular passage 'turns out'" (Sloboda, p. 103). In short, "the composer rejects possible solutions until he finds one which seems to be best for his purposes. The improviser must accept the first solution that comes to hand" (p. 149).

Sloboda (1985, pp. 102–103) recognizes four possible approaches to gaining insights into composers' compositional processes: (a) examination of composers' sketches and notebooks, (b) examination of what composers say about their own compositional processes, (c) "live" observation of composers while they are composing, and (d) observation and description of improvisatory performance. Sloboda recognizes several limitations of the first two approaches, noting that composers' sketchbooks and notebooks are particularly unsatisfactory for cognitive psychology because they can not explain the unconscious processes a composer may use in bringing to consciousness a highly structured composition (p. 114). Besides the inherent concerns contemporary psychologists hold with respect to verbal reports, composers' writings about their compositional processes may be limited by the accuracy of a composer's memory regarding the processes he or she went through while composing a particular piece. Sloboda suggests that the most detailed and accurate description of a compositional process is to be gained "by examining verbalizations made *concurrent with* the act" (p. 123).

Sloboda (1985, pp. 123–138) describes two composers' protocols for compositions, one for a fugue by an unidentified composer and an account of h[is] own composition for choir and organ. He notes that the composer of th[e] fugue began with certain constraints and as additional constraints built u[p] over the course of the composition, it appeared to become impossible [to] honor all constraints. The composer appeared to resolve this dilemma b[y] either (a) temporarily dropping some constraints, (b) changing the con[s]traints, or (c) modifying the new material to conform with earlier con[s]traints.

In his own highly insightful compositional protocol, Sloboda also bega[n] with several constraints, citing particularly his compositional style, which h[e] characterized as "twentieth-century English church" that emphasize[s] melody, counterpoint, and a strong tonal harmonic framework (p. 125), an[d] that the work should be for four voice parts and organ. His protocol essen[tially] presents a number of questions he posed during the process and th[e] rationale for and nature of the decisions he made in order to satisfy his con[s]traints and other self-imposed criteria for making the work as cohesive an[d] musical (aesthetically satisfying) as possible. He notes that he eventuall[y] reached a point (about measure 50) where he feared that stopping to recor[d] his thoughts in words would cause him to lose some momentum, and subse[quently] composed 35 measures without interruption. He maintains that hi[s] compositional strategy for the uninterrupted measures differed from that fo[r] the previous 50 measures for which he had provided a protocol, and con[cludes] that "the requirement to provide a protocol may well alter, even dis[rupt] entirely, the process one is trying to describe" (Sloboda, p. 136).

Sloboda draws three additional conclusions from his experience of pro[viding] a protocol for the composition. First, despite the detail he provided his protocol still left much unsaid regarding the compositional choices made. Second, he reported that throughout the process, he tended to use previously written material as starting points for continuations, trying to make the continuations "fit" the earlier material. Finally, he suggests that "an important component of compositional skill is a degree of 'trust' in one's medium—a certainty that the habitual processes of generation will yield material which is richer than one first sees" (p. 138). Nevertheless, Sloboda views protocol description as "an essential first step in understanding any complex mental process" (p. 138).

Theoretical Perspective

Sloboda (p. 116) recognizes two stages of composition: the "inspiration" stage, "where a skeletal idea or theme appears in consciousness," and the "execution" stage, "where the idea is subject to a series of more conscious and deliberate processes of extension and transformation." He finds it useful

to divide a "typical" composer's compositional resources and processes into two broad categories: "unconscious" and "conscious." He suggests that a composer employs certain long-term knowledge, which includes a general tonal and stylistic knowledge and a set of "superordinate constraints on form and direction." The composer brings his or her long-term knowledge, which Sloboda classifies as unconscious, into play while working with an idea for a composition and develops it into a thematic kernel for the composition. As the composition develops, the composer applies certain techniques from a repertoire of compositional devices to develop the work into an intermediate form which he or she, through a series of goal alterations and subsequent judgments regarding its "rightness," eventually molds into its final form. Allowing for goal alterations is important because it allows "discovered properties of intermediate themes . . . [to] actually overwrite originally held goals, so that the composition can appear to the composer to generate its own momentum or 'life,' almost independently of his will" (Sloboda, p. 119). Determining the sources and nature of unconscious processes underlying a composer's inspirations is difficult to recall or ascertain; consequently, most composers' accounts of their compositional processes essentially are accounts of their conscious compositional processes.

Emmerson (1989), who also recognizes "conscious" and "unconscious" dimensions to composers' compositional strategies, suggests that an understanding of a composer's strategies can be useful in composition pedagogy. He notes differences between traditional written composition and in electroacoustical composition, where the composer works with taped sounds or from computers and can immediately obtain aural results, which provide material about which he or she can make judgments and act upon decisions (p. 136). He offers two compositional models based on his experience with composition of electroacoustical music, and suggests that they have relevance for all genres of contemporary music. His "simple" model of composition has three aspects: (a) ACTION (create/combine the sounds), (b) TEST (listen and determine whether they *sound right together*), and (c) ACCEPT (store) or REJECT (modify as new ACTION). He notes that the notion of TEST has both local and more general aspects, the former relating to the composer's previous experiences and the latter to "groups of like minded people . . . and conceivably to audience participation also" (p. 137). Emmerson notes that a limitation of compositions using the simple model is that they are "embedded within the social psychology of . . . real time" (p. 137); that is, what sounds right essentially depends upon the extent to which the sounds conform to existing practice and preference rules.

Emmerson's elaboration of the model incorporates three new aspects: NEW ACTION, an ACTION REPERTOIRE, and REINFORCEMENT. Essentially, the elaborated model allows composers to incorporate either

rule-based (conscious, learned) or intuitive (unconscious) bases for decision made as a result of the TEST phase of the model. If the TEST phase result in a decision to REINFORCE the action, even though it might violate som rule-based system, the composer's ACTION REPERTOIRE is extende and available for use in NEW ACTIONS. Emmerson suggests that the con sequences of NEW ACTIONS need research and music psychologists ma wish to analyze what makes a particular action or strategy sound "right." H cautions that the TEST phase is critical–"the sole arbiter of taste remain human" (p. 143).

Lerdahl's (1988, pp. 231–233) discussion of Boulez's *Le Marteau sai Maître*, which was "widely hailed as a masterpiece of post-war serialism" (p 231), exemplifies a composition that reflects Emmerson's elaborated mode Lerdahl observes that experienced listeners seem to find a certain compre hensibility in *Le Marteau* that is not always found when listening to seria works. Ostensibly, the work is a serial work, constructed according to th rules of serial composition, but, according to Lerdahl, Boulez also "shape his material more or less intuitively, using both his 'ear' and various unac knowledged constraints" (p. 232). Lerdahl contends that "the degree t which *Le Marteau* is comprehensible, then, depends not on its serial organi zation but on what the composer added to that organization" (pp. 232–233

Lerdahl suggests that Boulez actually employed two kinds of *musical gram mars* in composing *Le Marteau:* a *compositional grammar*, "consciousl employed by Boulez, that generated both the events of the piece and thei serial organization . . . [and a] *listening grammar*, more or less unconsciousl employed by auditors, that generates mental representations of the music (p. 233). Thus, Boulez relied on both the rules of serial composition and hi experience as a listener in creating *Le Marteau.*

A fundamental problem of contemporary composition is that some com positional grammars (rules of contemporary composition), which Lerdah terms "input organization," may bear little relation to rules of listening gram mars and other intuitive constraints, which he terms "heard structures (Lerdahl, p. 234). He contends that this "gap" between the two grammar "divorces method from intuition," leading composers either to create an work with their own "private code" or with "no compositional grammar a all" (p. 235).

Lerdahl notes that "with the exhaustion of tonality at the turn of the [twen tieth] century, anything became possible . . ., [and] composers reacted b inventing their own compositional grammars" (p. 235). He suggests that suc an "avant-garde aesthetic" allowed composers to believe their own system were the wave of the future. Such personal systems now appear merely arbi trary. "The avant-garde has withered away and all methods and styles ar available to a point of confusion" (p. 236). He cautions young composer

against giving up on compositional grammars and depending solely on "intuitive constraints"—ear and habit. He argues that compositional grammars are necessary for composers, but that they should take into account musical perception and cognition, which are critical variables in developing listening grammars: Compositions must be comprehensible to knowledgeable listeners. For Lerdahl, comprehensibility "is a necessary if not sufficient condition for value" (p. 255). He goes on to make two claims regarding the aesthetic of composition:

1. The best music utilizes the full potential of our cognitive resources.
2. The best music arises from an alliance of a compositional grammar with the listening grammar. (pp. 255–256)

Simonton's (1980, 1984, 1994) content analysis of *compositional creativity* in 479 classical composers' melodies supports the view that "aesthetically successful" compositions must be comprehensible to listeners. Employing a methodology called *historiometry,* which involves testing hypotheses about human behavior "by applying quantitative analyses to data concerning historical individuals" (Simonton, 1990, p. 3), he computer analyzed the first six notes of 15,618 themes of classical composers' works listed in Barlow and Morgenstern's (1948, 1976) thematic dictionaries. He calculated a *melodic originality* value for each theme; melodic originality was defined as the "inverse of the mean probability for all five [two-note] transitions for each theme" (Simonton, 1994, p. 34).[9]

Simonton (1997, pp. 107–122) conveniently summarizes his major findings as they relate to "aesthetic success," which is his term for repertoire popularity. His objective indicators of aesthetic success, based on computer-generated melodic originality values, revealed that "the popularity of a composition is an inverted backwards-J function of originality" (1997, p. 111).[10] In essence, if melodic originality is extremely low or extremely high, the composition seems to be less popular in the classical repertoire than works for which melodic originality is in the middle range, i.e., original enough to be interesting to a knowledgeable listener but not overwhelming.[11] Obviously, other variables such as composer eminence, musical form (e.g., instrumental versus choral, chamber versus orchestral), and other compositional attributes

[9]A "transition" is the intervalic change from one note to the next. Some transitions (successive intervals) are far more likely (probable) than others. For example, in a C major theme's opening, a change from G up to a C# is far less likely than a change from G up to C.

[10]A "backwards-J" is like an inverted-U with a longer downward slope (right side) than rising slope (left side).

[11]The inverted backwards-J repertoire popularity-melodic originality relationship is similar to the inverted-U relationships experimental aestheticians have found for complexity and liking and familiarity and liking, discussed in Chapter 8.

(e.g., originality variation, metric originality) may influence particular works' popularity in the classic repertoire. Even allowing for the effects of these variables, most of which he addresses in other studies, Simonton reports that his objective measures of aesthetic success (primarily melodic originality, but also originality variation and metric originality) correlate positively with measures of aesthetic significance and listener accessibility. He summarizes:

> Popular works must be both significant and accessible, and yet significant compositions score high in melodic originality and originality variation while accessible compositions score low on these same thematic attributes. The peak of the [inverted backwards-J] curve then represents the compromise between these two contradictory tendencies. Compositions with a moderate amount of melodic originality and originality variation will be aesthetically significant without being too inaccessible. (Simonton, 1997, p. 113)

In short, Simonton's data support the theoretical perspective that aesthetically successful composition must consider both structural and listener aspects.

Compositional Approaches of Selected Composers

Even given the limitations of verbal accounts of compositional processes, Fulmer's (1995) review of 12 contemporary composers' reported approaches to composition offers some insights into the psychology of composition, particularly regarding how composers plan and structure their works. This section relies heavily on Fulmer's review, which is based on several sources: (a) his personal interviews with two composers—Dennis Kam and Sherwood Shaffer; (b) articles about composers—Andrzej Panufnik (Osbourne, 1984; Truscott, 1987) and Sir Michael Tippett (Bowen, 1981); (c) composers' own published accounts of their compositional strategies—Steve Reich (1968) and Robert Erickson (1994), and (d) published accounts of interviews with composers—Glenn Branca (Gagne, 1993), Elliott Carter (Edwards, 1971; Restagno, 1989), David Del Tredici (Canarroe, 1989; Moravec, 1992), Witold Lutoslawski (Varga, 1975), Karlheinz Stockhausen (Tannenbaum, 1987), and Iannis Xenakis (Zaplitny, 1975).

As might be expected, Fulmer's review reveals that different composers use different strategies and some composers use more than one strategy. For example, Andrzej Panufnik often begins by creating geometric shapes or designs, which provide a skeletal framework for his melodic, harmonic, and rhythmic concepts. Iannis Xenakis, trained as an engineer and architect, plans his compositions using mathematical processes from theories of probability, calculus, game theory, mathematical logic, and set theory.

Glenn Branca conceptualizes an entire work before starting a composi-

tion, thus enabling him to maintain a "Gestalt" of the work throughout the compositional process. Karlheinz Stockhausen also plans the overall structure of a composition prior to beginning actual composition, and he remains faithful to his plans until the work is completed. Sir Michael Tippett states that he usually begins by "mapping out" an entire composition, including the length and formal structure. In the actual composition process, Tippett involves himself physically by singing many of the sounds as he composes.

Elliott Carter begins with a general plan for the overall work, but indicates that he has "many of the details of the local events only very generally in mind" (Edwards, 1971, p. 104). Carter also assigns instruments a "character type," with each reflecting its own personality. This use of instruments to suggest character or personality usually evolves after a work is underway. Carter also notes that he sometimes sketches out possible solutions to problematic situations until he comes to a solution that satisfies him.

The late Polish composer Witold Lutoslawski began with an overall conception of a work and developed what he called "key ideas," which were bases for the overall composition. Key ideas may include melodic themes, formal ideas, a particular order, some technical procedure, or a particular sonority or harmonic entity. Both the overall conception and the key ideas were necessary before Lutoslawski began a work.

Dennis Kam initially plans the formal structure of a composition, which he usually considers in relation to previous and/or forthcoming compositions in order to create a larger structure. He tries to maintain the integrity of the initial formal structure, but occasionally alters it during the compositional process. Kam uses colors, visual images, and titles as unifying ideas for many of his compositions. Certain aspects of his compositions are "modular" and may appear in more than one composition. Fulmer notes that Kam reports that the composition's preplanning stage often is more exciting than actually composing the work and suggests that because Kam's compositions usually are interconnected with other compositions, "his music is a continual generative process" (p. 8).

David Del Tredici collects notebooks of periodically occurring musical ideas, themes, and patterns, to which he then returns in search of ideas for a new work. He notes that the process is analogous to having a group of nonrelated words that need organization into sentences to make sense. Similarly, he must organize his musical fragments to make sense of them, a process somewhat akin to fitting pieces of a puzzle together. Del Tredici composes at the piano; any orchestration occurs only after completion of the work.

Robert Erickson's compositional process is based primarily upon his remembrance of nonmusical sounds, which he collects, combines, and then recombines in a musical context. Once a sound captures his interest, he imagines how he can use it in varied musical contexts. The new sounds sug-

gest other sounds, creating a "snowball of sounds," which may form the basi of a new composition. He purportedly translates the nonmusical sounds int musical sounds via some subconscious process and indicates that intuition i critical to his entire process. He believes that "there are cognitive sides of hi psyche that make logical and practical decisions for notation, but it is th intuition that is of most importance" (Fulmer, 1995, p. 7).

Sherwood Shaffer may use one of three bases for pre-compositional plan ning: (a) a program, such as a story line or picture; (b) shapes, which hel outline the overall drama and formal structure; and (c) "figure themes," which are essentially motives or other thematic material.

American minimalist Steve Reich appears more concerned with a com position as a process in and of itself; consequently, extensive preplannin appears less important than for other composers. As Fulmer states,

> in understanding Reich's compositional process, it is important to understand that his musical language derives from repetitive, cyclic, and rhythmic themes. . . . Reich looks for a simple motive or germ that can start the process and run all the way through it, gradually changing and manipulating the piece as it travels. Once the process is set, the piece works itself out. For Reich, compositional process and the sounding music are the same thing. (Fulmer, p. 9)

Fulmer notes that all of the composers report using some type of precompositional strategy as an idea and/or organizing basis for their compositions. These may include shapes, stories/texts, key themes/ideas, planned formal structures, and/or other nonmusical ideas or abstractions. Several composers (Carter, Del Tredici, Erickson, Kam, Reich, and Shaffer) apparently make changes and solve composition problems as their works emerge. Stockhausen, Tippett, and Xenakis, however, apparently develop an overall plan for their compositions and strictly follow their plans until completing their works.

This brief overview of several composers' approaches to composition reveals that one may approach the creative process from a variety of perspectives. While composers may give somewhat similar accounts of the ways they approach a composition, Fulmer maintains that each composer's cognitive processes and aesthetic experience are unique (p. 10).

Composition Theory

The authors would be remiss if they failed to mention a relatively new approach to understanding the cognitive processes underlying music composition. The approach, *artificial intelligence and music* (AI and music), uses computer technology to develop models of human cognitive processes when engaged in musical activity. Models exist for a variety of cognitive processes related to music (e.g., listening, analyzing, performing, perceiving, improvis-

ing, and composing), but the present discussion is limited to applications related to music composition. Readers interested in pursuing research on AI and music processing other than composition should consult one or more of the following excellent sources (Balaban, Ebcioglu, & Laske, 1992; Clarke & Emmerson, 1989; Pressing, 1988; Smith, Smaill, & Wiggins, 1994).

Balaban, Ebcioglu, and Laske (1992) suggest that major differences exist between traditional AI research and AI and music. They note that modeling music cognition is fraught with difficulties, particularly given that the reference domain of music is difficult to define. Even if one focuses on the processes of music composition, the context for the processes remains elusive. For example, what is being modeled: Creative processes? Or problem solving processes? How does the aesthetic enter into the model? Are we concerned with modeling cognitive processes underlying composition of traditional Western tonal music, various contemporary musics, other musics of the world, music of popular cultures, or all of the above?

Obviously, initial efforts to model compositional processes via AI and music technology and theory required setting parameters. Balaban, Ebcioglu, and Laske (1992) use the term *compositional theory* to "designate a new discipline of music research oriented toward an empirical theory of compositional processes in music" (p. 182). An outgrowth of computer applications in music, the theory is considered empirical because it is based on empirical data regarding the mental processes of composition as indicated in composers' think-aloud protocols, retrospective reports, and other documents monitoring and reporting action sequences of musicians engaged in computer-aided composition. Traditional composers' personal statements, as reported in the preceding section, are considered anecdotal and thus inadequate as a foundation for compositional theory as a scientific discipline (p. 183). Most AI models for music composition also are limited not only by the multifaceted constraints with which composers must deal, but also by the nature and stylistic limitations of the musical genre a given model seeks to emulate and the capacity of the computer system and programs. Also, some models appear to be developed for gaining insight into the processes underlying the compositional process, whereas others appear to be developed for use in generating computer-assisted music compositions. Regardless of the model's motivation, each model offers insights into the process of music composition. A few models are noted briefly here to provide an indication of the directions and extent of work in the area.

Ramalho and Ganascia's (1994) emphasis on musical memory's role in their model of compositional tasks revealed two basic problems: (a) the problem of defining and building "musical memory" and (b) gaining information from experts regarding how to retrieve, modify, and fit events from musical memory into a given musical context. Working within the framework of jazz improv-

isation, they noted that musicians have great difficulty in expressing the rules they supposedly use and that the rules musicians provide "cannot be directly interpreted in a computational formalism" (p. 145). Their model also recognized that musical context is a major consideration in model development.

Jones (1989) notes that models of music composition have been developed for both stochastic and nonstochastic contexts. Essentially, *stochastic* contexts involve statistical bases for some "decision-making" while *nonstochastic* contexts involve algorithms or sets of rules as guidelines for decision-making. He describes the use of *fractal models* in composing melodies; the essential property of a fractal model is self-similarity (Jones, p. 180). He also describes two "recursive techniques," *space grammars* and *L-techniques*, which he considers powerful tools for generating self-similar models.

Ames and Domino's (1992) *cybernetic composer* "is an example of music-theoretic empiricism" (p. 186). Able to compose in four genres–"standard" jazz, Latin jazz, rock, and ragtime, the cybernetic composer can access several different models for each genre regarding how pieces may be structured. Ensembles for each genre have four layers: solo part, background chords, bass lines, and drums, and because the instrumental roles for jazz, rock, and ragtime are well defined, "the program often gives the illusion of true interplay when the layers are actually going their separate ways" (p. 187).

Another program, *Wolfgang*, was "designed to guide its compositional process biased by a cultural grammar of music, as well as by a *disposition* for crafting musical phrases such that they express a specific emotional characteristic" (Riecken, 1992, p. 210). Essentially, for making a given compositional decision within a given grammatical context, Wolfgang defines a set of possible solutions from its domain knowledge of music that satisfy the cultural grammar and then selects the solution that best satisfies Wolfgang's current disposition in order to embed a specific emotive potential into a given musical phrase.

Obviously, the variables underlying the development of valid composition models are many and complex. Marsella and Schmidt (1992) and Laske (1992) discuss many such problems. Certainly, many problems require resolution before compositional theory yields any explanation that is sufficiently multifaceted, broad, and inclusive to convince nonbelievers in AI that the models developed via AI and music offer any final truth regarding the diverse and complex processes that musicians employ when creating a new composition. Research on AI and music continues.

Composition as a Teaching Tool

Just as improvisation, composition now is recognized as an important musical activity through which children can learn music. The focus here also

is more on the process than on the product, and the primary concern seems to be to provide children with opportunities to explore and structure sounds into a musical whole without the constraints of traditional notation-based approaches to composition. Most approaches allow children with little formal musical training to use various instruments (often pitched and non-pitched percussion instruments) and computer-generated sounds to create music individually or in groups.

Along with this movement has come a limited amount of research regarding children's composition. Essentially, this research is ethnographic: The data primarily are based on more or less systematic observation of children's compositional processes and strategies, observations of interactions among students working on group compositions, student records, interviews, and the compositions themselves. A brief account of some typical studies follows.

Stauffer's (1999) five-year longitudinal study of children's composition revealed that they develop understanding of musical elements and styles, learn how to create both affect and effect in their original works, and, particularly for older children, develop functional understanding of notation and symbols. Computers and appropriate software facilitated children's musical learning primarily through repeated opportunities to manipulate musical elements in musical contexts developed by the children themselves. With experience, the children came to consider themselves composers and "became increasingly fluent at developing expressive ideas in their music" (Stauffer, p. 93).

Just as for improvisational experiences, collaborative experience appears to be an important mode for learning through composition, and several researchers have studied some effects of student collaborative efforts (e.g., Hamilton, 2000; Miell & MacDonald, 2000). Hamilton observed that peer interaction served two functions, one positive (furthering and sharing knowledge) and one negative (distracting from learning). Miell and MacDonald examined the role of friendship among children involved in collaborative composition and found that communication patterns differed between children working with friends and children working with nonfriends. Also, teacher ratings of the final compositions produced by friends were significantly higher than for those produced by nonfriends.

Other researchers (e.g., Burnard, 1999; Kratus, 2001; Younker, 1998) have focused more on children's processes and strategies for composition, as well as factors influencing the processes and strategies. Burnard found that the instrument used in composing and the child's technical ability on that instrument influenced the nature of the compositional process and product. Kratus observed that melodic configuration (and the number of bars available on an Orff xylophone used in creating the compositions) influenced the time spent exploring during the compositional process and the compositions' lengths and ending tones. Younker found differences in eight-, 11-, and 14-year-olds' composing behaviors and their treatment of timbre, beat, melody, and harmony.

As this cursory examination of research on children's musical composition and the earlier discussion of children's improvisation suggest, composition and improvisation no longer are the sole domain of experts. Children without highly developed musical and technical skills now have the opportunity to experience the processes of composition and improvisation. Researchers are just beginning to study the processes and strategies children employ in composing and improvising. Some insights gained in such research may facilitate understanding of the processes used by musically trained adults.

Summary

The major points of this chapter include the following:

1. Musical creation and performance provide essential stimuli for all other musical behaviors.
2. Musical performance is psychomotor behavior, where the mind guides the muscles.
3. Practice techniques vary with the performer, performance medium, and musical situation.
4. Mental rehearsal may be beneficial in conjunction with physical practice.
5. Expert performers are more likely than novices to practice intact meaningful musical segments in response to an error.
6. Practice is more than simply going over the music; it entails purposeful planning for musical goals.
7. Performance expertise is beyond just playing or singing well.
8. Expert performers may employ abstractions, based on meaningful musical groupings.
9. Execution of a musical performance involves cognitive structures, which vary among memorized performance, sightreading, and improvisation.
10. Musical expression may arise from musical structure or may shape it.
11. Performers' practice patterns may suggest their structural conceptions.
12. Performance anxiety is normal; many musical, personal, and situational variables influence it.
13. Careful preparation, anticipation, and goal setting may help control performance anxiety.
14. Common to many instances of performance anxiety is the performer's excessive concentration on himself or herself rather than the music.
15. Performers need to place the importance of any one performance in perspective in relation to their overall lives.
16. Improvisation involves extemporaneous performance of newly created

music.

17. Improvisation in Western art music reached its peak during the baroque era.
18. Today, most people associate improvisation with jazz.
19. Improvisation involves a continuing series of highly complex instantaneous neurological processes.
20. Skilled improvisers develop a vast "repertoire" of neurological connections that may be triggered during the improvisation process.
21. Concomitant with the development of this repertoire is the development of movement patterns for overt realization of one's improvisations.
22. Pressing maintains that any model of improvisation should explain how people improvise, how they develop improvisational skills, and the origin of the novel behavior.
23. The essence of most jazz improvisation is the melodic line.
24. Studies show that reliable evaluations of improvisations in relation to particular criteria are possible.
25. Collaborative improvisation is emerging as an important approach to teaching music and other collaborative behaviors to children.
26. Improvisation and composition differ; an improviser has constraints of immediacy and fluency and must accept the first solution that arises, whereas a composer may reject solutions until he or she finds one that seems best for a given purpose.
27. Four approaches to studying composers' compositional processes include (a) examining sketchbooks, (b) examining what composers say about their compositions, (c) observing composers' in-process composition, and (d) observing improvisatory performance.
28. Examination of protocol descriptions seems to be an important step in understanding the complexities of composition.
29. Two broad stages of composition are inspiration and execution.
30. Most composers' compositional strategies include conscious and unconscious dimensions.
31. Theorists suggest that composers must employ both compositional and listening grammars.
32. According to Lerdahl, the best music utilizes a listener's full cognitive potential.
33. Simonton's *historiometric* analyses of classical composers' themes revealed that compositions with extremely high or low melodic originality are aesthetically less successful than compositions with middle-range melodic originality.
34. A review of composers' descriptions of their compositional strategies suggests that one may approach composition from various perspectives.
35. Compositional theory, an outgrowth of work in music and artificial intelligence, offers a promising direction for studying compositional processes.
36. Composition is becoming an increasingly important tool through which children experience and learn about music.

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Chapter 8

AFFECTIVE BEHAVIORS AND MUSIC

As psychologists become increasingly concerned with affective behavior in its various manifestations, several questions require attention. For example: What is meant by *affect* and *emotion*? Is *aesthetic behavior* the same as *affective* behavior? Are changes in physiological rates affective responses? Can the affective and aesthetic be examined from a behavioral perspective? Or, are philosophical explanations of aesthetic experience sufficient? This chapter examines such basic questions in relation to four broad topics: (a) extended definitions of central terms, (b) the probable range of affective behaviors, (c) some approaches to studying affective responses to music, and (d) musical meaning and variables that contribute to musical meaning.

Extended Definitions

Affective responses to music are largely covert, and researchers studying affective responses encounter many of the difficulties inherent in studying music cognition. Terms used to describe affective response essentially reflect psychological constructs inferred from observable behavior. Also, the various terms and implied constructs used to denote affective response to music are not discrete; discussions of them are confounded further by seemingly loose and indiscriminate applications of the terms.

Three terms central to this discussion are *affect*, *emotion*, and *aesthetic*. While the terms may have a philosophical basis, the present discussion examines them from a psychological perspective. The distinction between philosophical and psychological uses of the terms is not clear-cut, although traditional usage recognizes their subjective and personal connotations. Other terms defined briefly include *attitude, interest, taste, preference, appreciation,* and *sensitivity*.

Affect

Observers of human behavior long have recognized three basic categories: thinking, feeling, and doing. Today, many psychologists and educators refer to these categories respectively as cognitive, affective, and psychomotor behaviors or "domains." Affective behaviors include those that

have a significant *feeling* dimension. Such "feeling" is aroused by a stimulus; in essence, the stimulus operates on the perceiving organism. This contrasts with the cognitive and the psychomotor, where the organism operates on the stimulus. This is evident in high quality musical performance, where the performer must employ cognitive processes to interpret a composition and psychomotor processes to play or sing, and yet obtains a sense of pleasure from being able to make beautiful sounds. With sufficient knowledge, one can eloquently describe the climactic and lighting factors involved in a seascape or sunset, yet the "beauty" of the scene may arouse an affective response quite independently of any scientific knowledge or lack thereof.

As used in everyday life, feeling has varied meanings, e.g., tactual perception (to *feel* a piece of cloth), cognitive belief (one *feels* something to be true), emotion, or simply whether an experience is pleasant or unpleasant. Although psychologists do not use the term consistently, Young (1973) recognizes eight classes of affective processes: (a) *simple feelings* of pleasantness or unpleasantness in response to sensory stimuli; (b) negative and positive *organic feelings* such as hunger, thirst, dietary satisfaction, or physical well-being; (c) *activity feelings,* including appetitive states of hunger, sexual desire, or other activity feelings such as enthusiasm or aversion; (d) moral, *aesthetic,* religious, or social sentiments and attitudes based upon previous experiences, education, and training; (e) persisting *moods* such as cheerfulness, elation, anxiety, or grief; (f) pathological *affects* of deep depression, apathy, or hostility; (g) *emotions* such as fear, anger, laughing, agony, or embarrassment; and (h) *temperaments* such as vivaciousness, cheerfulness, or moodiness.

Obviously, affective responses of any classification may vary in degree or intensity. Krathwohl, Bloom, and Masia's (1964) classic taxonomy of educational objectives in the affective domain suggests that affective responses to an object, event, or experience may be at one of five broad levels, ranging from simply being willing to observe or participate (minimal commitment) to incorporating an activity or experience into one's lifestyle (maximal commitment). Applying this notion to music, Abeles and Chung (1996, p. 287) classify simple mood or emotional responses to music as low level responses, preferences as mid-level responses, and musical taste as reflection of long-term commitment and valuing. McMullen (1996, p. 393), whose views regarding music's activation/arousal potential are discussed later in this chapter, premises arguments for his two-dimensional framework for affective/aesthetic response to music on strength of commitment to music, which he considers as an acceptance-rejection continuum.

Thus, affect is a broad term applied to a wide variety of human feeling behaviors, and the type or level of feeling resulting from an object, event, or experience may vary. The problem is exacerbated by the fact that affective processes may relate to virtually everything that is psychological—perception

memory, learning, reasoning, and action. Therefore, any discussion of affective behavior in relation to music must be defined in terms more definitive than just whether or not it has an affective dimension.

Emotion

One school of thought regarding music's import is that it conveys or expresses emotion. Certainly, performers often express particular emotions by employing various expressive cues such as tempo and dynamic variation (Juslin, 2001, pp. 324–326), and music may arouse strong emotional experiences as it interacts with listener aspects such as physical well-being, memories, and personality, and with situational aspects such as location, acoustic conditions, and social aspects of an audience (Gabrielsson, 2001, pp. 443–445). However, proponents of the emotional communication position tend to use the term *emotion* in a broader sense than most contemporary psychologists. Young (1973, p. 750) defines emotion as a disturbed affective process or state *"which originates in the psychological situation and which is revealed by marked bodily changes in smooth muscles, glands, and gross behaviors."* As this definition suggests, emotional behavior is a departure from the normal state of composure. Schubert (1996, p. 19) concurs, noting that emotion describes a "transient human condition that involves several dimensions, the most important being *valence* (positive or negative) and *arousal*." Emotions also involve perception and memory, include an environmental factor–present or past, may be positive or negative, and include an arousal dimension.

Meyer (1956, pp. 13–32) long ago theorized how music arouses emotion.[1] Central to Meyer's theory is the view that arrest or inhibition of a tendency to respond arouses emotion. An individual's tendencies to respond to music result from previous experiences with music of the style to which he or she is listening. From previous experiences, an individual develops expectations (tendencies to respond) regarding the types of patterns that might come next in the music. To the degree that the anticipated patterns are not forthcoming, i.e., they are delayed or do not come at all, *tension,* or *emotion,* is aroused. Some simple examples of delay of musical expectations include the deceptive cadence (V_7 – vi, as in a G chord to an A chord in C major) instead of an authentic cadence (V_7 – I, as in G to C) and the rapid repetitive alteration of I – V_7 – I – V_7 – I in a coda section, resulting in a "when will it end already" feeling.

Meyer's theory, essentially a conflict theory, is not without criticism. Miller (1992, p. 422) cites two deficiencies: (1) the theory lacks a satisfactory means for "sorting out affect or emotion after the arousal takes place," and

[1]As will be apparent in the discussion of musical meaning, Meyer's classic theory of emotion in music uses the term *arousal* in a more limited sense than other psychologists (e.g., McMullen, 1996).

(2) the theory does not provide "a good explanation of why pleasant emotions are aroused." Miller notes that most interruptions would seem to cause surprise, frustrations, or annoyances.

Nevertheless, listeners to Western music appear to learn that certain chords or sound terms imply certain other musical entities. When an appropriate expected musical consequent is delayed, suspense is aroused. However, Meyer recognizes that mere arousal of tension via the inhibition of musical expectations is of little import in itself. For the tension or emotion to result in *aesthetic meaning,* it must be followed by a fulfillment of the expectation (e.g., the expected chord is reached; the composition finally comes to a clear end) and hence resolution of the tension.

Most recent applications of theories of emotion such as Meyer's to musical experience essentially elaborate and/or refine a basic theory of emotion, but reflect language and refinements consistent with the authors' theoretical perspectives (e.g., Dowling & Harwood, 1986, pp. 214–219). More will be said regarding these theories later. The important point here is that theories of how music creates emotion are consistent with the contemporary psychological viewpoint that emotion is a relatively temporary disruption of a normal state. Further, emotion is seen as an essential component of aesthetic meaning, although emotion alone is, in Meyer's words, "aesthetically valueless" (p. 28).

Aesthetic

Aesthetic feeling is a particular type of affective behavior and is the outcome of aesthetic experience. The term *aesthetic* usually is used in relation to art and its value or meaning, although aesthetic feeling may result from interactions with natural phenomena, or with nonart objects or events. Interactions are of special importance within the context of the present discussion because we are speaking of an experience more than of any object or "work of art." Indeed, as Elliott (1995) and Small (1998) suggest, the concept of a musical "work" as an entity separate from its performance and the experience thereof may be questionable.[2] What makes some interactions *aesthetic* and others not has been subject to much philosophical discussion, to the point that aesthetics traditionally is viewed as a branch of philosophy. While philosophical theory and discussion provide many valuable insights regarding the nature and value of aesthetic feeling and experience, the present discussion also recognizes aesthetic feeling and experience as psychological behaviors that are subject to study via the same methods used to examine other aspects of human behavior. Psychologists only recently have begun

[2]The views of Elliott and Small are discussed further in the context of musical preference within Chapter 9.

to study aesthetic behavior, while philosophical examination of the aesthetic has a long history. To the extent that psychologists are able to substantiate philosophical theory regarding aesthetic behaviors, theory will be strengthened.

Common to most discussions of aesthetics is a concern for beauty, and definitions of beauty have their own difficulties. When one says something is beautiful, he or she is reflecting a value judgment, but what causes the individual to value something as beautiful has been subject to considerable debate. Some hold that beauty is inherent in the object or event because of its structure or form; i.e., beauty is a property of the object or event and remains so regardless of what an individual respondent might "feel." An opposing view is that "beauty is in the eyes (or ears) of the beholder." Perhaps Saint Thomas Aquinas, as cited by Rader and Jessup (1976, p. 20), stated it best: "Let that be called *beauty*, the very perception of which pleases." That statement has two implications: First, beauty gives pleasure, and second, not everything that gives pleasure is beautiful, but only that which gives pleasure in immediate perception. Which position reflects the greater truth regarding the determination of beauty has been and will continue to be subject to debate and conjecture. The point here is that, for most people, beauty is the subject matter and stimulus for aesthetic experience and feeling. While the notion that response to beauty is the basis for the aesthetic response seems plausible, not all aestheticians and writers on aesthetics agree that the aspects of music which contribute to its aesthetic value fit neatly into a rubric of *beauty*.

Aesthetic experience is the term most often used to describe subjective, personal response to beauty or the other aesthetic qualities of an object, event, or phenomenon. Hargreaves (1986, p. 108) argues that the term is applicable to "more or less any reaction that any person might have to any work of art, defined in the broadest possible terms." For Hargreaves, a school girl's like-dislike reaction to a current pop record and a music critic's critique of a Beethoven symphony both reflect aesthetic experience. Other writers, however, are more delimiting in what they consider aesthetic experience.

Two advocates of aesthetic education, Bennett Reimer (1989, pp. 99–117) and Gerard L. Knieter (1971, pp. 3–20), also recognize aesthetic experience as human experience. They recognize the importance of beauty in nature and other objects and events that are not necessarily considered art, but they generally discuss aesthetic experience in relation to artworks.

Knieter cites five characteristics of an aesthetic experience: (a) focus, (b) perception, (c) affect, (d) cognition, and (e) its cultural matrix. *Focus* suggests that an individual must devote attention to the artwork and respond thereto. *Perception* is viewed as the process through which sensory data are received and through which the individual becomes aware of the artwork. Knieter

sees two basic types of *affect* occurring during the aesthetic experience, physiological change and feelingful reaction. Concomitant with aesthetic experience are changes in blood pressure, respiration, and electrodermal response. The feelingful reaction may vary from simple feeling to complex emotional sets. *Cognition* is a particularly important attribute of aesthetic experience, reflecting the intellectual processes involved: analysis, synthesis, abstraction, generalization, and evaluation. Knowledge and learning regarding the stylistic attributes of a musical work contribute greatly to the quality of an aesthetic experience. Finally, the *cultural matrix* is reflected in the aesthetic experience because one learns aesthetic values within a cultural context.

Reimer emphasizes that an individual's interest and reactions must be absorbed by or immersed in the aesthetic qualities of the music to which the individual attends; the feelingful reaction must be to the *expressive aesthetic qualities* rather than to any symbolic designation. For Reimer, music's aesthetic qualities conveyed by melody, harmony, rhythm, tone color, texture, and form are "expressive of or analogous to or isomorphic with the patterns of felt life or subjectivity or the conditions of livingness" (p. 102). The individual must be involved with the music's *embodied* meaning rather than with any symbolic designations.[3] Reimer also maintains that aesthetic experience is valuable in and of itself, is not a means toward nonaesthetic experience, and serves no utilitarian purpose. Taken at face value this might suggest a contradiction of the authors' view that aesthetic experience serves a human function and that music also serves other functions. This is not the case. While aesthetic experience may appear to have no purpose or *use,* it still serves a valuable *function,* providing an individual an opportunity for feelingful experience above and beyond meeting basic human needs. Maslow (1970, p. 5) contends that aesthetic experience is a basic human need, albeit one with which people become involved only when their physiological, safety, and certain psychological needs are met. Therefore, an aesthetic experience is valuable in and of itself to the experiencing individual; the very fact that the experience holds value for the individual suggests that it is functional to his or her well-being.

Reimer's final characteristic of an aesthetic experience is that it must involve the qualities of a perceptible "thing." The "thing" is the sensuous element, the "formed substance," containing the aesthetic qualities which an individual perceives and to which he or she responds.

Implicit in both Knieter's and Reimer's descriptions is that aesthetic experience requires psychological *involvement* with the aesthetic stimulus, *perception* of interacting events within the artwork, *cognition* of the interplay among

[3] *Embodied* musical meaning results from expectations *within* the music, whereas *designative* meaning refers to meaning *symbolized* by the music. The differences are discussed in more detail later in the chapter.

the events within the aesthetic stimulus, and *feelingful* reaction thereto. Aesthetic experience differs from most affective experience in that it must involve perception and *cognition* of an aesthetic stimulus. There is something more than just an "oh how pretty" reaction. Yet, without the immediacy of the aesthetic stimulus, the affective behavior can not be an aesthetic behavior.

For an experience to be aesthetic, it must result in feelingful reactions to perceived interactions of those aesthetic qualities contributing to the beauty or meaning of an artwork or other stimulus with which an observer (listener to music) is involved perceptually. Such a definition of aesthetic experience does not deny, however, that music and other aesthetic stimuli elicit many other significant affective responses. Certainly hearing a composition with which one has had previous associations may elicit feelings regarding those associations. Meyer (2001, p. 348) notes that music, as well as other sounds, may evoke emotional responses due to associations with other music, natural sounds, cultural activities, and individual experiences. For example, hearing a theme from a previously seen movie generally elicits thoughts and feelings regarding the movie. However, to say that such a feeling is aesthetic is questionable; for Knieter and Reimer it probably lacks sufficient focus on the auditory stimulus itself. On the other hand, the elicited feelings may be very meaningful to the individual. In the authors' view, such feelings reflect another type of affective response to music.

Other Definitions

Several additional terms will be mentioned briefly because each suggests a psychological construct with a substantial affective component. Essentially these constructs are covert and therefore inferred from an individual's behaviors (including verbal) relative to the objects, events, or phenomena that are the stimulus for the affective response. While the definitions are neither discrete nor exhaustive, they reflect the terms' general meanings as used in the literature. The definitions essentially are the same as the authors have offered elsewhere (Boyle & Radocy, 1987, pp. 195–199).

Attitude, the most general term, connotes a predisposition toward mental or psychomotor activity with respect to a social or psychological object, event, or phenomenon. The predisposition may be either positive or negative, reflecting either approach or avoidance activity. Kuhn (1979) notes that an attitude is relatively long term and stable and that any real changes in attitude necessarily occur over a considerable period of time.

Interest suggests feelings of concern, involvement, and curiosity. A clear demarcation between "attitude toward something" and "interest in something" is difficult, but in common usage, interest more often is manifested

through active participation or involvement with the object, event, or phe nomenon, while attitude is more covert and suggests more of a value judg ment.

Taste, as applied to music, usually suggests an element of connoisseurship reflecting some agreement with the "experts" regarding quality and excel lence. Kuhn equates taste with attitude, because both essentially imply cover predispositions, develop from experience, and appear to be long term i nature. However, experience apparently influences all affective responses.

Preference usually is more overt, or behavioral, than taste or attitude i that preferences usually involve making choices and indicating them in som overt manner. Abeles (1980) suggests that preference and taste actually rep resent a continuum from a short-term (preference) to a long-term (taste) com mitment.

Price (1986) recognizes *behavioral preferences* and *behavioral intentions* as tw important modes for expressing preference. A behavioral preferenc involves demonstrating choices through nonverbal actions such as conce attendance or recording purchase, while a behavioral intention requires th verbal expression of a choice one would make in a specific decision-makin context.

Appreciation with respect to music appears to be used both narrowly an broadly. Lehman (1968, p. 25) notes that appreciation broadly includes major knowledge component–knowledge of musicians, notation, literatur instruments, history, and so forth. More narrowly, appreciation places mor emphasis on an individual's sensitivity to aesthetic qualities.

Sensitivity usually implies perception of and responsiveness to sensor stimuli and reflects both cognitive and affective dimensions. In commo usage, it implies making both subtle discriminations and subtle feelin responses. Considering these connotations, it is not surprising that the ter *aesthetic sensitivity* is very common in the literature.

Types of Affective Response to Music

Suggesting that aesthetic experience is the only important feeling respons music elicits denies the value of a broad spectrum of affective behavior related to music. The present discussion does not purport to consider rela tive value of the respective types of affective behaviors in relation to aestheti experience per se, but it recognizes that various affective experiences ar important to greater or lesser degrees for many individuals. The relative val ues of the various affective modes obviously differ among individuals. It i unlikely that any given affective mode, even the aesthetic mode, is of greate or lesser value for all individuals.

The variety of affective responses to music is great. Concomitant with a

types are *physiological reactions* of the autonomic nervous system. Hector Berlioz's descriptions of his reactions while listening to a piece of music, as reported by Schoen (1940, p. 103), included increased blood circulation, violent pulse rate, muscle contractions, trembling, numbness of the feet and hands, and partial paralysis of the nerves controlling hearing and vision. While it is doubtful that many individuals' physiological mechanisms are affected to the extent that Berlioz claimed, objective evidence exists that changes in certain physiological rates do accompany affective behaviors. Whether these changes themselves are affective behaviors is subject to interpretation. The behaviorist might insist that they are because they are observable (via certain measuring instruments); an opposing view is that they merely are physiological correlates of affective behavior, because feelings by definition are psychological rather than physiological.

A common affective behavior is the *mood* or *character* response. In Western cultures certain musical sound patterns appear to characterize different psychological mood states. Certain music may be soothing or relaxing, other music may make an individual feel happy or sad, while still other music may elicit feelings of frustration or agitation. The range of moods that music may characterize is as great as the range of moods people can feel. There is no question that music can elicit mood response; further, within a given cultural context, many individuals tend to agree regarding the moods elicited by certain types and examples of music. While the variables underlying mood responses are many, one should recognize that whatever mood response music elicits is much more than a response to any inherent mood or character of the music. Mood responses to music, just as virtually all other response to music, essentially are determined by an individual's previous experience with music. *Learning underlies all musical behavior, affective or otherwise.*

An individual's previous *associations* with music in general, and especially particular pieces, also may influence affective response. The most common example of this is when an individual responds to music's programmatic content. Feelings of this type usually relate to an event or story that the individual has previously associated with the music. The popularity of movie soundtrack recordings suggests that many people want to re-experience the narrative through listening to the music. The same types of associations are made with opera and musical comedy. The feeling response is much more than to the music itself. Listening to music of one's childhood or adolescence may evoke feelings from those years associated with that music. Lovers may recall special occasions through "their song." Music's power to elicit strong feelings of experiences associated with it provides individuals with a mechanism for re-experiencing many significant events of their lives.

While philosophers and aestheticians have been greatly concerned with the wordless meaning of music, relatively little study of the feelings evoked

by song lyrics has occurred. One only has to listen to the words of folk, pop-
ular, and art music, however, to realize that the music's verbal messages ar
primarily affective. Feelings of love, frustration, and virtually every deep-
seated and persisting type of human feeling that individuals may hold towar
one another have been verbalized through song. Feelings expressed or elicit-
ed through blues, country-western, rock, and rap music are primary exam-
ples of the affective impact of combining word meanings and music.

Words and music also have been combined to express and elicit affectiv
reactions to all types of social, political, and religious issues. Music has bee
used as a persuasive tool throughout history. As noted in Chapters 2 and 3
many of music's basic functions and applications are to sway feelings. Ther
is little doubt that patriotic, social protest, and religious songs can arous
strong affective response. Such songs are symbols, perceived and reacted t
accordingly, and serve a legitimate and important function (Reimer, 1989, p
121).

Many additional human behaviors related to music have an affectiv
component in greater or lesser degree. Musical *preferences* (discussed i
Chapter 9), musical *interests*, musical *values*, *attitudes* toward music in genera
and toward various musical styles, and *appreciation* of music all reflect affec
tive components. Because these behaviors also depend in many respects o
knowledge, their importance to music educators is great. Appreciation, val
ues, and preferences are of essence to music education. Interests and atti
tudes are central to both the process and outcomes of music education.

Approaches to Studying Affective Responses to Music

The study of affective responses is fraught with many of the same issue
and problems inherent in the study of other aspects of human psychologica
behavior. Defining, isolating, and measuring the various affective construct
is especially challenging, particularly given the diversity of behaviors involv
ing affect, the potential range of response intensities, the lack of discretenes
among the constructs and terminology, and the confounding measuremen
and evaluation problems. As Abeles and Chung (1996, p. 286) note, th
same measurement techniques often are employed to measure purportedl
different constructs.

While the measurement and research problems are many, traditiona
approaches to study of affective responses to music roughly fall into thre
broad categories: (a) physiological measures, (b) adjective descriptors, and (c
philosophical inquiry. A fourth approach, following Berlyne (1971, 1974)
focuses on examining empirical human responses to musical stimuli. Terme
empirical or *psychological aesthetics*, this approach represents a major develop
ment in music psychology. The four approaches obviously overlap in sever

al aspects; for convenience, they are discussed separately.

Physiological Measures

Few musicians or psychologists deny that music can evoke changes in the rates of bodily processes, but there is little or no agreement regarding the degree to which such changes reflect affective responses to music. Affective behaviors are *psychological* behaviors, whereas measures of the rates of various bodily processes are *physiological* behaviors. The study of physiological-psychological relationships is called *psychophysiology* (Sternbach, 1966, p. 3). If one is seeking to understand affective responses to music through the study of changes in the rates of bodily processes, then one should be engaged in psychophysiological research.

Bartlett (1996, p. 348), however, notes that establishing direct relationships between physiological and psychological responses is difficult, particularly for physiological responses resulting from autonomic nervous system responses to relatively simple onset stimulus events, such as audible music. He suggests, though, that the more a listener incorporates memory and associative experiences into the listening experience, the more complex the reaction; thus, the more "psychological" the response and the more likely it may reflect some fundamental feeling or affect.

With few exceptions, most research examining physiological responses to music stops short of examining direct relationships with psychological behaviors. Most studies simply involve presenting a musical stimulus as the independent variable and using polygraph data regarding various physiological rates as the dependent variables. The underlying premise of most such studies is that the frequency and/or amplitude of the various bodily processes controlled by the autonomic nervous system reflect affective response to music. The most frequently studied dependent measures include heart and pulse rate, respiration rate and amplitude, and electrodermal activity (skin responses, formerly called psychogalvanic reflex, galvanic skin response, or GSR). Other measures include *electroencephalography* (EEG)–a technique for recording various brain wave rhythms; *electromyography* (EMG)–a measure of muscle tension; *electrooculography*–a measure of eye movement; *pupillography*–a measure of pupil size; *electrogastrography*–a measure of gastrointestinal response; *patellar reflex*–knee-jerk response; and the *pilomotor response*–movement of hairs on the skin.

Schoen (1927, 1940), Diserens and Fine (1939), Lundin (1967), and Farnsworth (1969) have summarized most of the early research on physiological responses to music; more recent reviews include those by Dainow (1977), Hodges (1980b), and Bartlett (1996). Readers interested in the particulars of such research should consult these sources, especially Bartlett's com-

prehensive review. Bartlett's review is particularly valuable because it provides chronologically organized brief synopses of major studies for each of the following types: (a) heart and pulse rate; (b) skin conduction (electrodermal activity); (c) respiration; (d) blood pressure; (e) muscle tension and motor activity; (f) motor/postural response; (g) peripheral skin temperature; (h) blood volume; (i) stomach contractions; (j) biochemical response; and (k) miscellaneous studies, including blood-oxygen saturation, pilomotor response, pupil dilation, and pupillary reflex.

Review of all the research related to physiological responses and affect is far beyond the scope of the present discussion. Therefore, the present discussion largely is based on Dainow's (1977), Hodges' (1980b), and Bartlett's (1996) excellent reviews and critiques.

As noted above, most studies merely describe physiological responses to various musical stimuli rather than true affective responses. They indicate particular physiological concomitants of affective response, but, with the exception of a few studies, no attempts were made to examine relationships between these physiological responses and affective responses. Two notable exceptions are Dreher's (1948) comparison of subjects' verbal reports and GSR responses to various types of music and Ries's (1969) study of breathing amplitude and emotional reactions to music. Dreher found that musically trained subjects showed a high positive relationship between GSR and mood as measured by adjectives checked on the Hevner Adjective Circle; data for untrained subjects revealed no relationship. Ries found a statistically significant positive correlation between "extroverted" subjects' breathing amplitudes and reported enjoyment of musical excerpts heard; data for "introverted" subjects yielded a negative correlation.

Philosophers and musicologists long have maintained and sought to substantiate the existence of a relationship between heart rate and music. Most "substantiation," however, has just been rhetoric. Dainow's review of studies of heart rate in response to music provides virtually no support for the hypothesis that heart rate varies with musical tempo. Of eight studies examining the effects of music on heart rate, all but one failed to elicit any statistically significant change in heart rate. Bartlett's review of 62 studies of heart rate in response to music or sound yielded 15 showing increased rates (to stimulative music), 25 showing decreased rates (to sedative music), and 28 showing no change. Hodges' review, focusing specifically on the effects of stimulative and sedative music, yielded results similar to those of Bartlett. Thus, data for heart rate response to music are inconsistent and, for those studies that do yield observable effects, depend on whether the music is stimulative or sedative. Heart rate has yet to be substantiated as an adequate measure of affective response to music.

Dainow notes that summarizing research on respiration rate or amplitude

is particularly difficult because of the variety of experimental conditions. Some studies examine rate while others examine amplitude; further, some research sought to examine respiration rate in relation to tempo, while other research attempted to relate respiration to listeners' attention or enjoyment. Other than the Ries study mentioned above, most other studies examined by Dainow reported no clear-cut data regarding the relationship between respiration rate or amplitude and either a musical stimulus or a verbal response; they merely described the responses to musical stimuli. Bartlett, however, reported seven studies yielding increased respiration rates, two yielding decreases, and six yielding no changes. As is apparent for heart rate research, respiration research provides ambiguous data regarding the affective response to music.

Dainow maintains that electrodermal (GSR) experiments are even more incomplete and inconclusive than those for heart rate and respiration. Noting that some studies measure magnitude and direction of response, some the number of deflections, and others the rising period or response latency, he observes a general methodological "hodgepodge" in GSR research. Some have attempted to relate GSR to various ill-defined emotional responses to music, while others have examined it in relation to stimulative versus sedative music or dissonant versus consonant sounds. Despite occasionally well-conceived studies such as Dreher's (1948) comparisons of verbal reports and GSR to different types of music, Dainow maintains that little can be concluded regarding GSR and affective response because of the many methodological problems. Bartlett's review also yielded studies with divergent results: Four, including the Dreher and Ries studies, reported a positive relationship between GSR and an affective dimension, four yielded no positive relationship with an affective dimension, and the majority simply revealed changes in electrodermal response to a musical stimulus. The authors concur with Dainow's conclusion.

Electromyography, or muscle tension, perhaps holds more promise as a reflection of affective response to music than most other physiological measures. Western music appears to organize sounds to develop tension-resolution patterns, and Dainow suggests that "it might be expected that inherently tense music could induce a corresponding physical or muscular tension in the listener" (p. 214). He cites research by Sears (1957, 1960) as evidence that music may alter muscle tension. Bartlett found that nine of twelve studies reviewed reported significant changes (decreases) in muscle tension. Most of those studies used sedative musical stimuli, some of which were in conjunction with biofeedback. Thus, electromyography research has demonstrated clearly that music can decrease muscle tension, but whether such changes are changes in affect is problematic.

Readers interested in research results for other physiological measures

should consult Bartlett's (1996) excellent comprehensive review. Bartlett notes that for 153 hypotheses tested in the various studies he reviews, 61 percent yielded results that seemed to correspond with intended outcomes (p. 375). Obviously, the "success rate" varied for different physiological measures, but, clearly, music can induce changes in various physiological processes for some people. Bartlett notes that the effect seems to be more prominent when the musical stimulus is preferred music, which perhaps elicits greater listener interest and response. But the question remains: Do these changes reflect affective response?

Another much-studied type of physiological response to music is brain wave response. While research on brain wave response to music has not focused primarily on brain waves as a measure of affect, the interest in hemispheric specialization and music gave rise to considerable research and much speculation regarding brain activity and musical processing. The research focus primarily has involved perceptual or conceptual responses to dichotic listening[4] situations. Critical reviews do not always interpret the research in the same way (Gates & Bradshaw, 1977a, 1977b; Hodges, 1978, 1980a, 1980b, 1996; Marin & Perry, 1999; Radocy, 1978, 1979; Regelski, 1978; Webster, 1979), but two general conclusions, offered by Boyle, Cole, Cutietta, and Ray (1982, p. 10), have received and maintained general acceptance: "(1) hemispheric differences are to a considerable degree a function of the nature and complexity of the musical task, and (2) there are differences in the hemispheric activation on given musical tasks for musically trained and untrained subjects." Hodges' (1996, pp. 222–232) recent review and critique of research using dichotic listening tasks as measures of hemispheric asymmetry yielded similar conclusions: "Perhaps laterality effects in audition are due not only to the type of sound being processed (verbal or nonverbal) but also by the task required of the subjects and by subject attributes" (p. 232).

While some research on hemispheric specialization and music purportedly was undertaken to gain a better understanding of the affective response to music, partially in response to Regelski's (1978, p. 13) strong assertion that aesthetic thinking is a right hemisphere activity, little research has examined hemispheric specialization systematically as either an independent or a dependent variable in musical affect. Tucker's (1981) comprehensive review of hemispheric specialization and emotion, however, suggests that both hemispheres are involved. In short, brain wave research, including that on hemispheric specialization and music, provides little or no insight regarding

[4]In dichotic listening, the investigator directs separate simultaneous auditory inputs to each ear, thereby exploiting the anatomical fact that most of what enters the left ear eventually becomes a signal to the right cerebral cortex, and vice versa. The technique is not wholly satisfactory because there is some same side input, and cerebral processing often is not limited to the area of stimulus entry.

the affective response to music.

In addition to EEG research, several newer brain-imaging techniques offer further approaches to understanding the neurological bases of cognitive and affective responses to music. These include *magnetoencephalography (MEG)*, *magnetic resonance imaging (MRI)*, and *positron emission tomography (PET)*. Hodges (1996, pp. 241–252) presents overviews of these techniques' potentials as measures of brain activity while responding to various musical tasks. In addition, he provides an introduction to the neurobiology of emotion, which may come to serve as a research basis for musical affect. Peretz (2001) suggests that while neuropsychology or neurobiology of musical emotions is in its infancy, evidence exists for specific neural arrangements, although no one emotional system can account for all emotional responses to music. What will evolve from knowledge of new measurement techniques and the neurobiological bases of emotion remains to be seen.

While the above discussion suggests that measurement of physiological rates as a basis for assessing affective response to music is fraught with problems, a certain fascination remains with the notion that physiological responses reflect musical affect. In an effort to gain another perspective on the matter, Sloboda (1991) asked 83 music listeners to indicate (a) three "peak" emotional experiences they had when listening to music during the previous five years, (b) the music that elicited the peak experience, and (c) the nature of the physical response that accompanied the experience. The most common responses, shared by a large majority of respondents, were shivers down the spine, laughter, lump in the throat, and tears. Sloboda's analysis of the responses suggests that respondents were able to pinpoint precise musical events that gave rise to the physiological response and that their responses differed for different types of musical structure. Later, Sloboda (1992) reported that when 67 regular listeners were asked to describe their most valued emotional experience with music, 41 cited music as a change agent (as in relaxing feelings of tension), and 34 cited it as a way to intensify or release existing emotions.

Another study (DeVries, 1991) used Clynes's "sentograph" as a tool for assessing affective response to music.[5] DeVries examined responses of 30 people, some musicology students and some members of an amateur choir, to 11 short musical excerpts and observed that the subjects' responses were "fairly similar." Based on both visual and statistical analysis of the data,

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The sentograph essentially measures finger pressure on a finger rest. The respondent expresses an motion by applying pressure to the button. "The pressure applied to the button is measured over me, and in two directions: vertically (straight down) and horizontally (away from/towards the subct). The manner in which subjects push the button is thought to mirror their entire manner of ovement" (p. 46). Analyses of the response graphs, called "sentograms," allegedly represent "sen states."

DeVries maintains that the sentograph "indeed measures the affective response to music" (p. 46). The theory is that "music directly activates the action programs that drive the expression of emotions," (p. 63) but the movements presumably are in response only to the music's *affective* content. Obviously, this theory and approach need further testing before receiving general acceptance as a measure of affective response to music.

Clearly, physiological research to date provides few insights into the affective response to music. Reasons for this are difficult to pinpoint, although Dainow and Hodges suggest that many methodological issues are involved. Particular concerns include instructions to subjects, loudness of the musical stimuli, subject attention, and possible suppression of response due to fear of disturbing electrodes. Another major difficulty involves measurement of the psychological variable affect. In addition, the sheer diversity of physiological variables themselves and the many aspects of each create an overwhelming array of measurement and interpretation problems. Miller (1992, p. 419) suggests that even if one can demonstrate that somatic changes are "in sync" with musical activities, it may be merely an instance of "phenomenology without psychology." He notes that the aspects of emotional behavior that are observable and measurable differ from emotional experiences, which he maintains are not measurable.

Finally, even if all measurement and research design problems can be resolved, it may be that physiological responses are sufficiently unique to each individual, who also brings a unique experiential background to the measurement situation, that making predictions or generalizations about the affective response on the basis of physiological measurements is inappropriate. As Hahn (1954, p. 11) stated long ago, "an investigation of the physiological response may offer a clue but not a solution to the individual's psychological reactions."

Adjective Descriptors

Laypersons, musicians, psychologists, and philosophers agree that music can reflect moods and evoke mood responses in listeners. Mood responses to music, as other psychological responses to music, involve learning. Individuals within given cultural groups *learn* that music with certain characteristics reflects certain moods while music with other characteristics reflects different moods. Psychologists and philosophers have described moods in various ways, but as used in research related to music, *mood* generally refers to "relatively transient states . . . which can be cognized by individuals and designated with *words* [italics not in original]" (Eagle, 1971, p. 19).

The traditional approach to assessing mood response employs adjective descriptors, and most discussions of adjective descriptors as tools for assess-

ing responses to music are labelled as discussions of mood response to music (e.g., Eagle, 1971, pp. 27–80; Farnsworth, 1969, pp. 79–86; Lundin, 1967, pp. 160–172). On the basis of an exhaustive review of traditional literature regarding studying affective response to music via verbal descriptors, Eagle notes three basic methods for gathering verbal descriptions: (a) adjective checklists, (b) the semantic differential, and (c) various types of rating scales. The adjective checklist is the most commonly used of the three methods. A brief chronology and summary of early research using adjective checklists follows.

1927 Schoen and Gatewood presented 10 musical selections to 32 female subjects on two separate occasions under similar testing conditions. Based on a frequency count of the adjectives checked for each selection, the researchers concluded that "a given musical selection will arouse a certain definite reaction and will arouse the same reaction on different occasions" (Schoen & Gatewood, 1927, p. 151).

1927 Gatewood (1927) presented a list of 12 adjective descriptors to 35 female subjects, who checked the moods elicited by each of 10 selections. The study sought to examine the influence of rhythm, melody, harmony, and timbre on stated mood effects. Gatewood concluded that mood effects depend on definite musical elements.

1928 Heinlein studied adjectives checked in response to major and minor chords by 30 musically trained and untrained subjects. Two additional variables studied were intensity and pitch register. He found that mood effects were more a function of intensity than the chord per se. Further, pitch register also made a difference in which adjectives were checked. He concluded "any fixity of feeling-tone in relation to a given mode is dependent upon training to react in a specific manner to a purely intellectual discrimination" (Heinlein, 1928, p. 140).

1935 Hevner (1935, 1936) developed an adjective checklist which has served as the basis for much subsequent research on mood response to music. She developed an adjective circle grouping 67 adjectives into eight clusters, each cluster containing adjectives of approximately the same meaning (see Fig. 8-1). Listeners were asked to listen to musical excerpts and check the adjectives describing the mood. The intent was that as one progressed around the circle from cluster one to cluster eight there would be eight more or less discrete moods, representing a general trend of mood change through the respective clusters. Her results revealed a general consistency among subjects in the adjectives checked. She conducted a series of follow-up studies to ascertain the effects of various elements of music (modality, rhythm, tempo, harmony, melody, and pitch) on mood response. From these studies, she concluded that the major mode is "happy, graceful, and playful"; the

1
awe-inspiring
dignified
lofty
sacred
serious
sober
solemn
spiritual

2
dark
depressing
doleful
frustrated
gloomy
heavy
melancholy
mournful
pathetic
sad
tragic

3
dreamy
longing
plaintive
pleading
sentimental
tender
yearning
yielding

4
calm
leisurely
lyrical
quiet
satisfying
serene
soothing
tranquil

5
delicate
fanciful
graceful
humorous
light
playful
quaint
sprightly
whimsical

6
bright
cheerful
gay
happy
joyous
merry

7
agitated
dramatic
exciting
exhilarated
impetuous
passionate
restless
sensational
soaring
triumphant

8
emphatic
exalting
majestic
martial
ponderous
robust
vigorous

Figure 8-1. Hevner Adjective Circle.

minor mode is "sad, dreamy, and sentimental"; firm rhythms are "vigorous and dignified"; flowing rhythms are "happy, graceful, dreamy, and tender"; complex dissonant harmonies are "exciting, agitated, vigorous, and inclined toward sadness"; simple consonant harmonies are "happy, graceful, serene, and lyrical"; and differences in expressiveness caused by rising and falling of melodic lines are not clear-cut, distinct, or constant (Hevner, 1936, p. 268). Hevner (1937) reported that slow tempos express "dignity, calmness, and sadness" and fast tempos "restlessness and happiness." High pitches are "sprightly and humorous," while low pitches reflect "sadness, dignity, and majesty." She observed that responses were generally the same for listeners of all kinds, intelligent and less intelligent, trained and untrained (Hevner, 1939).

1952 After developing a list of 105 musical selections to match six mood categories, Capurso (1952) asked 1,075 "nonmusical" subjects to listen to the selections and categorize them according to mood. He found that 61 selections had listener agreement at least 50 percent of the time.

1954 Farnsworth (1954) tested the internal consistency of the clusters of the Hevner Adjective Circle. He observed that several clusters did not describe internally consistent mood patterns and therefore did not justify the circle arrangement. He rearranged 50 of Hevner's adjectives into 10 more consistent categories (see Fig. 8-2).

A	B	C	D	E
cheerful	fanciful	delicate	dreamy	longing
gay	light	graceful	leisurely	pathetic
happy	quaint	lyrical	sentimental	plaintive
bright			soothing	yearning
merry			tender	
playful			tranquil	
sprightly			quiet	

F	G	H	I	J
dark	sacred	dramatic	agitated	frustrated
depressing	spiritual	emphatic	exalting	
doleful		majestic	exciting	
gloomy		triumphant	exhilarated	
melancholic			impetuous	
mournful			vigorous	
pathetic				
sad				
serious				
sober				
solemn				
tragic				

Figure 8-2. Farnsworth's modification of the Hevner Adjective Circle.

1955 Sopchak (1955) developed a twelve-category adjective checklist which 553 college sophomores used in responding to 15 compositions, five classical, seven popular, and three folk. Subjects also classified their own moods on a three-point scale: "cheerful" to "neutral" to "gloomy." A higher percentage of gloomy subjects responded to sorrow, joy, calm, love, eroticism, jealousy, wonder, and cruelty.[6] Sopchak speculated that gloomy subjects have many tensions and thus more readily project into the music, while cheerful subjects may have less need to project into the music.

1960 Van Stone (1960) sought to ascertain mood differences associated with musical tone quality. Eight musical excerpts representing Hevner's eight clusters were orchestrated and recorded by three ensembles—string, woodwind, and brass. Results indicated no significant differences among adjectival responses to the three types of ensembles. Apparently timbre change had little or no effect on mood response.

While mood response in terms of adjective checklists has been subject to considerable study, the semantic differential technique offers another framework for eliciting subjects' responses to adjective descriptors. Essentially, the technique attempts to measure subjects' views, perceptions, or concepts of various phenomena by use of a series of bipolar adjectives between which they make a response on a five- or seven-point continuum.[7] For example:

Concept: Mood

Happy	____	____	____	____	____	Sad
Light	____	____	____	____	____	Heavy
Humorous	____	____	____	____	____	Solemn

Eagle (1971) used the semantic differential technique while seeking answers to three questions: (a) Does existing stated mood affect rated mood responses? (b) Does presentation order of music affect rated mood response to music? (c) Do similarly rated mood responses hold true for both vocal and instrumental music? Undergraduate and graduate music majors (n = 274) rated their present mood on a 10-point scale and then responded to 20 musical selections in terms of five pairs of bipolar adjectives (good-bad, pleasant-unpleasant, bright-dark, depressed-elated, and happy-sad). The 10 vocal excerpts included rock, folk, country-western, popular ballad, and hymns; instrumental excerpts included jazz, march, semi-classical, and classical.

[6]Strictly speaking, except for "calm," these words are nouns, not adjectives. Although the well-known Hevner list indeed uses only adjectives, nouns, as names of affective states or moods, occasionally appear on "adjective" lists.

[7]Readers interested in the semantic differential technique should consult the classic source, Osgood, Suci, and Tannenbaum (1957).

Eagle found that a listener's existing mood does influence mood response to music, but presentation order does not. Regarding his third question, Eagle states (p. 171) "similar rated mood responses do not hold true for both vocal and instrumental music. A person responds differently to vocal music than to instrumental music, although both may seem to reflect the same mood qualities."

Eagle's (pp. 70–80) analysis of the literature using adjective descriptors as a measure of mood response revealed various research concerns. Only three studies mentioned the reliability of their testing instruments. Over half of 43 reviewed studies reported no statistical analyses; of the 20 reporting statistical data, nearly half used only frequency counts. Eagle noted, however, that eight of nine studies conducted since 1960 employed more sophisticated statistical analyses. Findings were not consistent regarding the importance of particular elements in eliciting mood, although the review warranted the following broad generalization:

> Rhythm seems to be the primary element in evaluating mood responses to music. "Happiness" was the term used most often to describe fast tempi, major mode, consonant harmonies, and tunes pitched in high registers. "Excitement" or "agitation" described dissonant harmonies. (p. 79)

The semantic differential technique also is useful for assessing responses to music other than mood or character per se. Crozier (1974) and McMullen (1976, 1980, 1982a) are the technique's major proponents. Building on the work of Osgood, Suci, and Tannenbaum (1957), who demonstrated that the bipolar technique is viable for assessing affective response and identified three principal factors or dimensions (*evaluative, potency,* and *activity*) that account for most of the semantic loadings on factor analyses of responses on semantic differential scales, Crozier and McMullen each identified two dimensions of affective meaning based on their subjects' semantic differential responses to musical stimuli.

Crozier's (1974, p. 85) data suggest that these dimensions are reflected in *pleasingness* and *interestingness* ratings, which are "evidently close to Osgood's Evaluative and Activity dimensions, respectively." Both vary with the heard musical sequence's *uncertainty* or information content (in information theoretic terms), but in different ways. The former is related curvilinearly; the latter is related linearly.The *dimensional approach* for relating verbal responses to musical stimuli, according to McMullen (1976, p. 2), appears closely related to the adjective checklist approach. Both seek to identify aspects of the affective stimulus that influence responses. McMullen's dimensional approach seeks a statistical grouping of adjectives with similar meaning for a particular response dimension and identifies general dimensions that might apply to

many art forms. The checklist approach uses individual adjectives that collectively comprise a mood pattern and employs variables associated with musical structure.

McMullen examined the relationship between response to the Hevner Adjective Circle and some previously defined dimensions of *evaluation* (pleasing, beautiful, good), *potency* (interest, powerful, rugged), and *activity* (complex, clear, order). His data indicated some merit in Hevner's concept of arranging her adjective groups in a circle; two dimensions of semantic space, which he interprets as subfactors of the evaluative dimension, emerged. McMullen further suggests that a third factor, associated with the activity dimension, might have emerged if he had used additional activity-related adjectives in the study.

Analysis of adjective descriptors into underlying dimensions holds much potential for assessing affective responses to music and musical experience, and the approach is receiving increased usage. One of the most elaborate applications is Asmus's (1985) multidimensional instrument for the measurement of affective response to music. Called the *9-Affective Dimensions* (9-AD), Asmus's technique yielded nine dimensions of affect, which he named *Evil, Sensual, Potency, Humor, Pastoral, Longing, Depression, Sedative,* and *Activity.* Many others, including Gabrielsson (1973, 1979), Hargreaves and Coleman (1981), and Hylton (1981), have used the dimensional approach to assessment of affective response to music. While the dimensional approach, whether involving basic factor analytic techniques or even more sophisticated multidimensional scaling techniques, is useful (and now reasonably convenient) for analyzing adjective descriptor data, Hargreaves (1986, p. 125) cautions that "any dimensional model is ultimately restricted by the range of musical stimuli on which it is based, as well as on the subjects and response measures adopted." Further, interpreting the emerging dimensions involves the researcher's subjective judgments. Hargreaves suggests that dimensional approaches to the study of musical responses are still in their infancy and do not yet provide an adequate basis for drawing any firm conclusions about the broad dimensions of responses to music (p. 128).

Psychologists continue to use adjective descriptors as a means for assessing mood, character, and emotional responses to music, and Hevner's work of the 1930s provides a foundation for much of this research. Contemporary studies (e.g., Balkwell & Thompson, 1999; Schellenberg, Krysciak, & Campbell, 2000) make reference to and support her findings. Balkwell and Thompson, noting that most research using adjective descriptors employed Western listeners listening to Western music, investigated the extent to which Western listeners could recognize moods in Hindustani raga excerpts, recorded in North India. Postulating that listeners enculturated in Western tonal music could perceive intended moods (which they call emotions) in an

unfamiliar tonal system, they asked 30 listeners to rate the degree of joy, sadness, anger, and peace in 12 raga excerpts preselected to convey one of the four moods. Subjects were naive regarding the excerpts' cultural connotations; they based their ratings on the musical variables of tempo, rhythmic complexity, melodic complexity, pitch range, and timbre (a flute-string dichotomy). Subjects correctly identified the moods of joy, sadness, and anger as conveyed by the ragas, but not peace. Balkwell and Thompson believe the data support their cross-cultural model of emotion in music. Further, they note that the variance in ratings for joy and sadness could be associated with mean tempo ratings and that melodic complexity ratings were associated with ratings of joy (simpler melodies) and sadness (more complex melodies).

Schellenberg, Krysciak, and Campbell (2000) examined the effects of pitch and rhythmic variables on the perceived emotional content of six short melodies previously judged to convey one of three emotions: happy, sad, or scary. They developed three altered versions to provide pitch only, rhythm only, and baseline versions of each. Thirty undergraduate psychology majors rated the 24 melodies as conveying one of the three emotions. Pitch had a greater influence on ratings than rhythm. Rhythm made significant contributions to ratings of happy and scary melodies but only in interaction with pitch changes, which were the predominant influences on subjects' ratings. Although the number and nature of the melodies and moods examined were limited, the results revealed that structural variables are interactive and influence adjectival descriptions of mood or emotion in music.

Data regarding the effects of structural variables in both the Balkwell and Thompson and Schellenberg et al. studies were similar to what Hevner reported in the 1930s. Psychologists likely will continue using adjective descriptors as data for assessing mood and emotional response to music.

Philosophical Inquiry

Philosophical explanations regarding the value or meaning of artistic phenomena and experience have been a part of Western culture since the time of Plato, who is considered the founder of philosophical aesthetics (Hofstadter & Kuhns, 1964, p. 3). Writings in philosophical aesthetics abound. The range and diversity of views that have been offered regarding the value and meaning of art (and music in particular) have resulted in a philosophical quagmire, often engulfing those who are not well schooled in aesthetics. While philosophical inquiry by nature arouses divergent viewpoints, a cursory examination of some of the classical viewpoints may contribute to understanding the affective response to music, particularly since philosophical aesthetics represents the traditional and longest standing

approach to the study of people's responses to arts phenomena.

Berlyne (1974, p. 2) suggests that *speculative aesthetics* is the most apt term for disciplines traditionally called philosophical:

> They depend heavily on deduction–from definitions of concepts, from self-evident principles, from generally accepted propositions, from an author's own beliefs, intuitions, and experience. To a large extent, their method is "hermeneutic," i.e., they rely heavily on interpretive examination of particular texts, particular specimens of literary, musical, or visual art. Their ultimate criterion of validity is whether they leave the reader with a feeling of conviction.

Berlyne sees two divisions of speculative aesthetics: traditional *philosophical* aesthetics, usually taught in university departments of philosophy, and *art theory,* usually taught in the respective art, music, or literature departments. Philosophical aesthetics includes general statements regarding arts phenomena and their intent, value, or meaning, while art theory involves more examination of individual art works, art styles, and artists. Music courses that concern art theory as defined by Berlyne are music history, music appreciation, music literature, and, to an extent, form and analysis courses. As should be apparent, the various types of courses overlap considerably, and aesthetics comprises only one concern of a course. Speculative aesthetics generally is viewed as subjective in approach; other approaches to the study of affective response may be more objective, although verbal descriptions of music may be more subjective. The present discussion examines only philosophical aesthetics.

Readers interested in examining some of the classic aesthetic theories should consult a traditional text, such as Hofstadter and Kuhn (1964) or Weitz (1970), or any of several more recent sources that summarize, review, and/or synthesize various philosophical positions (e.g., Davies, 1994; Higgins, 1991; Reimer & Wright, 1992; Scruton, 1997). However, a sampling of some of the various theories' basic tenets suffices to illustrate the dilemma philosophical aesthetics holds for the uninitiated. Plato viewed art as *imitation* of an ideal–the beautiful and the good. Aristotle also viewed art as imitation, but in a different sense; for him, imitation was the realization of form in a sensory medium, and therefore art was a revelation of beauty.

Rousseau considered art as *expression.* French classicism turned art into arithmetic problems, while German romanticism sought explanations in metaphysical terms. Shiller viewed art as the most sublime form of play. Maritain suggested that all art begins for functional reasons and is a value of the practical intellect. Croce maintained that art is *intuition.* Schopenhauer saw music as the art *par excellence* because it "objectifies the world directly" and is "independent of the phenomenal world." Dewey viewed art as experience, reflecting the tension-release patterns of everyday life. Some other

theories, as capsulized by Schwadron (1967, p. 33),[8] include:

> Freud, desire and unconsciousness; Santayana, reason; Langer, symbolic transformation; Garvin, feeling response; Stravinsky, speculative volition; Schoenberg, logical clarity; Leichentritt, logical imagination; and Hindemith, symbolic craftsmanship.

To facilitate a modicum of order in dealing with aesthetic theories related to music, several writers have grouped aesthetic theories according to basic philosophical position (Meyer, 1956, pp. 1–3; Reimer, 1989, pp. 14–37; Schwadron, 1967, pp. 34–47). The basic viewpoints are summarized below.

The two most basic positions usually are classified as the *absolutist* and *referentialist* viewpoints, or in Schwadron's terminology, the *isolationist* and *contextualist*. Essentially, absolutist (isolationist) theories consider music's value or meaning to be the result of the musical sounds themselves and nothing more. For an absolutist, there is no musical meaning beyond that inherent in the sounds themselves. Meyer (1956, pp. 2–3) sees an additional distinction within the absolutist framework. An absolutist may be a *formalist,* who contends that musical meaning is primarily intellectual and based on perception and understanding of the formal structural relationships within a composition, or an *expressionist,* who views these structural relationships as capable of exciting feelings and emotions in the listener. The essential point regarding absolutist theories, however, is that any meaning or value derived from the music must be in terms of the musical sounds and nothing else. Eduard Hanslick (1957/1891) generally is recognized as one of the earliest proponents of the absolutist position. For Hanslick and other absolute formalists, music's values and meaning are derived entirely from the musical structure. In Hanslick's extreme view, the "true" music lies in the musical score; any performance is an imperfect representation of the structure contained within the score.

Absolute expressionism has gained a certain acceptance in recent years. This view holds that the meaning of music not only comes from the music itself, but from its *expressive* or *aesthetic qualities* rather than its structure or form. Cook (1990), who questions the extent to which listeners give attention to formal details, contrasts "musical listening," where people listen for aesthetic gratification, with "musicological listening," where they listen to establish musical facts or formulate theories. Absolute expressionism's major proponent, Bennett Reimer (1989), argues very eloquently that this philosophical position should be the basis for contemporary music education philosophy.

The other basic position, i.e., the view that music's meaning involves more

[8]For the novice to the study of aesthetics, Schwadron's highly readable and relatively short text remains an excellent introduction to the basic "isms" and more arcane aspects of aesthetics.

than the sounds themselves, including extramusical ideas, emotions, stories, and even spiritual states (Sullivan, 1927, pp. 27–37), is labeled the *referentialist* or *contextualist* position. Nearly all advocates of this position are expressionists; i.e., they view music as expressive of human experiences, although they also recognize that it can have other extramusical connotations.

Expressionism appears to be receiving considerable attention in some of the recent literature. Kivy's (1980) theory of expression has been well received, although not without criticism (Davies, 1994). Davies offers another theory of expression. Examination of these theories is beyond the scope of the present discussion, but readers interested in gaining an understanding of expressionism are encouraged to examine the work of Kivy and Davies.

A third position noted by Schwadron (1967, p. 42) is *relativism.* The relativist position allows for development of personally derived value criteria and recognizes that values are relative to and conditioned by cultural groups and historical periods. "For the relativist, musical meaning is a psychological product of expectation, an outgrowth of stylistic experience and cultural orientation" (Schwadron, p. 47).

Schwadron's (1984) review of research in music philosophy and aesthetics recognizes another direction of contemporary philosophical aesthetics: *phenomenology.* He cites 13 doctoral dissertations completed between 1974 and 1983 that were concerned with "the phenomenology of music." Following, and borrowing metaphors from, philosophical trends in the aesthetics of visual arts, phenomenological examination of music focuses on sound as *perceived* rather than physical sound.

Smith (1979, p. 54) views phenomenology as "an overcoming of metaphysics" and argues the need to develop appropriate language for sound instead of continuing to depend on visual metaphors. The phenomenology of music is still an emerging and evolving aesthetic philosophy, but its underlying focus on music as a perceptual phenomenon is more in keeping with contemporary psychological persuasions than the positions of traditional philosophical aesthetics.

Clifton's (1983) *Music as Heard: A Study in Applied Phenomenology* has been recognized as the most systematic application of phenomenological analysis to musical experience (Rao, 1992). Rao maintains that Clifton's view of music as "'the outcome of a collaboration between a person and real or imagined sounds' provides a humanistic, perceiver-oriented approach to musical aesthetics" (p. 52). Individuals concerned with understanding the affective response to music may gain an important perspective by examining Clifton's and others' writings in the phenomenology of music.

Another philosophical position that recognizes the importance of auditory perception is Harrell's (1986, pp. 23–28) *theory of partial recall.* Concerned with explaining the *depth metaphor* in music criticism, Harrell argues that

ascribing qualities of profundity to a musical work in essence describes one's experiencing of it and reflects the value it holds for the individual. Harrell theorizes that music characterized as "deep" or "profound" may trigger memory for, or *partial recall* of, prenatal auditory experiences that most likely emanated positive emotional qualities and states. Because the human fetus has a fully developed auditory mechanism from about the age of five months, but is devoid of visual and tactual sensory mechanisms and language as "ways of knowing" during these positive emotional experiences, the associated auditory experiences (sounds) hold increased importance.[9] Harrell suggests that music to which the quality of *depth* is ascribed (and depth may be ascribed to music of any culture or style, *not just Western art music*) may enable a listener to "momentarily 'be in touch' with a [positive emotional] state that was pre-linguistic as well as pre-visual and pre-tactual" (p. 28). She continues, arguing that music requiring visual explication for artistic import, particularly film music, may lack the qualities of depth that music recognized as profound through auditory perception may hold.

This cursory examination of philosophical aesthetics reveals few answers and considerable diversity regarding the affective response to music. No position has been substantiated empirically. Most information offered remains purely speculative, leading many individuals concerned with understanding affective response to accept some other philosophical positions noted by Schwadron (1967, pp. 34–35): complacency, eclecticism, skepticism, and agnosticism. Such philosophical positions, however, are not conducive even to attempting to understand affective responses to music. The authors encourage readers holding one of the latter philosophical positions to examine the section immediately below, particularly the subsequent section on meaning in music.

Psychological Aesthetics

Advocates of *psychological aesthetics* examine affective behavior in terms of human interaction with and response to musical sounds. Berlyne (1974, p. 4), whom many consider the founder of contemporary psychological aesthetics, equates psychological aesthetics with *empirical aesthetics,* which he defines as the study of aesthetic behavior through observation, using methods and objectives similar to empirical science. The bases for psychological aesthetics come from several disciplines, especially psychology, physiology, and speculative aesthetics.

In contrast to philosophical aesthetics, psychological aesthetics has a relatively short history. Berlyne (1974, p. 5) traces its roots back to Fechner's work in the 1860s and 1870s, but notes that its early products were relatively sparse and not very enlightening prior to 1960. Since about 1960, however, interest in the discipline has increased markedly and inspired new approaches, techniques, aims, and ideas.

[9]While memory of prenatal auditory experiences as a basis for valuing "deep" or "profound" music may be tenuous, there is little question that prenatal auditory experiences may affect postnatal auditory reactions (Lecaunet, 1996).

Psychological aesthetics may involve any of three basic methodologies: (a) *correlational studies,* which examine how two or more factors vary in relation to one another; (b) *content analysis and description,* which involve measurement of artistic and other artifacts of specific social groups or historical periods; and (c) *experimental aesthetics,* which examines aesthetic response through experimental methods, i.e., seeking through systematically varying some factors to determine their causal effect on affective behavior. Berlyne maintains that experimental methodology offers the greatest potential for understanding aesthetic response to music and outlines basic criteria and premises that underlie *experimental aesthetics.*

For research to qualify as experimental aesthetics, it must possess one or more of four features: (a) a focus on the collative (structural or formal) properties of the musical stimulus, (b) a concentration on motivational questions, (c) study of nonverbal as well as verbally expressed judgments, and (d) seeking links between aesthetic phenomena and other psychological phenomena. In addition, experimental aesthetics includes three basic premises.

First, an art work[10] is analyzed in information-theoretic terms; i.e., it is comprised of elements, each of which can transmit *information* of four types: (a) semantic, (b) expressive, (c) cultural, and (d) syntactic. Berlyne recognizes some overlap among the four types of information, but notes that the four information sources also emit independent information, thus setting up a competition among them. More information from one source generally allows less from the others.

The second theoretical premise is that art works are collections of symbols in accordance with the conception of signs and symbols in the semiotic movement.[11] Art works have properties in common with objects or events that they signify, thereby serving as symbols for communicating artists' values regarding which objects or events deserve attention.

The third theoretical premise is that an art work serves as a stimulus pattern whose collative properties give it a positive intrinsic hedonic value. Variables for measuring hedonic value include degree of pleasure, preference, or utility, which usually are measured via either verbal expressions or

[10]As noted earlier, the concept of music as a "work" may be troublesome (Elliott, 1995; Small, 1998). In music, the analyzed "work" is the ongoing experience of organized sounds and silences across time, not a static entity.

[11]Readers interested in information on the semiotic movement should consult Chapter 6 of D. E. Berlyne's (1971) *Aesthetics and Psychobiology.*

such nonverbal variables as reward value and incentive value. An art work that has "positive intrinsic hedonic value" is inherently pleasurable or rewarding, not because it serves as a means to an end. The pleasure or reward results from experiencing the organized sounds, not from any utilitarian function, such as filling silence, masking unwanted sounds, or energizing one for physical labor. Berlyne hypothesizes that positive hedonic values are a function of *arousal*–through a moderate increase in arousal or through a decrease when arousal has reached an uncomfortable high. The "arousal potential" of an art work's stimulus pattern for an individual depends on many factors, including intensity, association with or resemblance to experientially significant events, and collative properties.

McMullen (1982a, 1996), another strong proponent of psychological aesthetics, expanded on Berlyne's concept of arousal, or, as some call it, *activation.* He notes the key concept of arousal–the degree of action or activity by an individual–is the same whether viewed from a cognitive or behavioral perspective. He argues that the basic reason for including the concept of arousal at the core of psychological aesthetics is that it provides a bridge between what is perceived–the music–and the related feeling response.

When a person listens to and processes acoustic properties of music, he or she is, according to McMullen, responding perceptually in terms of the music's "energy" and "structure," which in combination serve to arouse or activate the listener. Both McMullen and Berlyne suggest that this activation or arousal provides the framework for the aesthetic response to music.

Dependent variables for experimental aesthetics may include verbal ratings, psychophysiological measures, and behavioral measures. The semantic differential has become the predominant framework for verbal ratings, and most contemporary research using adjective descriptors is considered part of the psychological aesthetics movement. Investigators employ three classes of scales: (a) *descriptive scales,* in reference to stimulus patterns' collative properties; (b) *evaluative scales,* reflecting hedonic value; and (c) *internal state scales,* for assessing subjects' reactions or mood while exposed to a stimulus. Psychophysiological measures generally are considered indicators of arousal rather than measures of affect, as in much of the previously cited psychophysiological research. Behavioral measures generally are *exploratory time* (in music, *listening time*) or *exploratory choice* (in music, *listening choice*). Exploratory time variously has been interpreted as a measure of intensity of orientation time, the intensity of attention, or perceptual curiosity, while exploratory choice is viewed as an index of incentive value or utility (Berlyne, 1974, pp. 13–14).

Independent variables in experimental aesthetics generally reflect the *approach* to experimentation. The *synthetic* approach involves a more or less laboratory setting, in which particular variables are isolated for manipulation

and study, while the *analytical* approach examines reactions to art and other aesthetic stimuli taken from real life. While the synthetic approach has obvious advantages, McMullen (1978) argues that a great need exists for music psychologists to examine musical behaviors from the latter perspective. He maintains that the psychology of music reflects too much the one-sided position of psycho*acoustics* rather than psycho*music.* Berlyne (1974, p. 18) notes that both synthetic and analytic approaches are necessary, but he too recognizes that the synthetic approach has been the dominant approach for much research.[12] Independent variables generally are structural or formal characterizations, i.e., an art work's collative properties, and their effects frequently are evaluated within an information theory framework.

Research in psychological aesthetics continues to develop in several directions. The psychophysiological approaches, using measures of various physiological rates as dependent measures, and the adjective descriptor approach, particularly studies of dimensionality reflected in the descriptors, have received renewed emphasis and direction from the theory, methodology, and research of contemporary psychological aesthetics. The major developments in psychological aesthetics, however, seem to be emerging through research using experimental methodology focusing on the collative properties of musical stimuli such as "complexity, novelty/familiarity, redundancy/uncertainty, and orderliness, and various measures of 'aesthetic' response including liking, interestingness, and subjective familiarity and complexity" (Hargreaves, 1986, p. 110). The collative variables generally serve as independent variables and the various measures of aesthetic response the dependent. Relationships within and between the two variable classes obviously are highly complex, and examination of them is fraught with many semantic, measurement, methodological, and theoretical problems and issues. The present discussion is intended to serve as an introduction to the theory and issues and to provide an overview of some of the research directions using experimental methodology. Readers interested in more information on contemporary experimental aesthetics should examine Hargreaves' (1986, pp. 110–122) and his colleagues' (North & Hargreaves, 1997, pp. 84–103; Sluckin, Hargreaves, & Coleman, 1982) thorough and lucid reviews of the literature and issues.

Research in music using the theory and methodology of experimental aesthetics appears spearheaded by one of Berlyne's associates, J. B. Crozier (Bragg & Crozier, 1974; Crozier, 1974). In the United States, Patrick McMullen continues to be the chief proponent (McMullen, 1976, 1977,

[12]The synthetic-analytic approach conflict is far from limited to psychological aesthetics. In any research involving human subjects, one may face the dilemma of the need to sacrifice reality in the interest of experimental control, or the need to sacrifice experimental control in the interest of reality.

1982a, 1982b, 1996; McMullen & Arnold, 1976). Perhaps the strongest research thrust in recent years comes through the work of David Hargreaves and his colleagues in the Leicester Aesthetics Research Group in England (e.g., Hargreaves, 1982, 1984, 1986, pp. 110–122; Hargreaves & Coleman, 1981; North & Hargreaves, 1997, pp. 84–103; Sluckin, Hargreaves, & Coleman, 1982).

Much of these scholars' research relates to what Smith and Cuddy (1986) term the "classical model of aesthetic preference," the *optimal-complexity model.* At least some aspect of the theory pervades most research in experimental aesthetics. The theory's origin generally is attributed to Berlyne (1971), but it has been tested and modified over the years by various researchers, including Heyduk (1975), Davies (1978), and Walker (1981). Because many issues and problems central to research in experimental aesthetics are grounded in the assumptions of the optimal-complexity model, the balance of the present discussion examines research in experimental aesthetics as it relates to the theory's assumptions, which Smith and Cuddy (pp. 17–18) conveniently summarize:

1. The critical aspect of a stimulus that determines its hedonic, or positive affective value, is its complexity. Complexity is measured by the amount of variability or uncertainty associated with an event. In terms of information theory, it is directly related to the amount of information conveyed by an event and indirectly related to redundancy.
2. The relation between complexity and affective value may be described by an inverted U-shaped curve. In other words, an intermediate level of complexity elicits maximum positive affect; lower and higher levels of complexity elicit less positive affect.
3. The effect of stimulus exposure (repetition, training, practice) is to lower stimulus complexity and, by consequence, to alter the affective values of stimulus patterns. For example, a pattern whose preexposure complexity was on the high side of the optimal point of complexity would move toward the optimal point with repetition, and its attractiveness would increase. The pattern formerly at the optimal point would become lower than optimal complexity, and its attractiveness would decrease. The result is that a higher level of complexity, as measured by the preexposure scale, is now required to elicit maximum positive affect.

Most of the general assumptions of the optimal-complexity model relate to the effects of the stimulus's collative attributes. However, the collative attributes of a musical stimulus are not simple, isolated variables.

Complexity, usually the central variable, may be either *objective,* a function of the stimulus attributes varied according to some systematic and objective procedure, or *subjective,* the apparent perceived complexity, which is

assumed to be a function of the interaction between the stimulus's objective complexity and the listener's musical knowledge, experience with the musical style and/or idiom, and familiarity with the particular musical stimulus.[13] In reality, most collative variables are *relativistic;* i.e., their qualities depend on the interaction between the structural attributes of the musical stimulus and the listener's prior experience with music in general, the style and/or idiom, and the particular piece. Subjective complexity is similar to the notion of *conceptual meaning,* discussed in Chapter 6.

If complexity is relativistic and is measured in terms of the musical stimulus, as the optimal-complexity model assumes, then the uncertainty/certainty continuum, another generally accepted collative variable, also must be considered relativistic, i.e., a function of both stimulus structure (*structural redundancy*) and the listener's experience with such music (*cultural redundancy*), with the net effect being *perceptual redundancy.*

Research tends to support the first general assumption. Crozier (1974) used a synthetic approach to examine the effects of uncertainty in melodic structure. He found that variations in information, i.e., varying levels of uncertainty, affected subjects' ratings of "pleasingness" and "interestingness." Further, he reported a "remarkably high degree" of inter-predictability between mean verbal ratings and nonverbal measures of exploratory behavior.

McMullen and Arnold's (1976) study of the effects of distributional redundancy on preference and interest response for rhythmic sequences also suggests that redundancy influences both preference and interest. Preference tended to increase as redundancy decreased to a point, after which preference began to decrease; interest generally increased as redundancy decreased.

Smith and Cuddy (1986) examined the effects of (objective) harmonic complexity on 36 university psychology students' "pleasingness" ratings of 20 melodic sequences. The melodic stimuli previously were classified into five complexity levels "according to the rules defining tone sets and tone progressions in classical Western European music" (p. 21). Essentially, the level of uncertainty or redundancy, as reflected by degree of tonality or tonal strength, was the variable of concern to the present discussion. Results indicated that pleasingness ratings varied with level of objective harmonic complexity. Analysis of data according to subjects' level of musical training revealed that pleasingness ratings also varied according to level of musical training. Their data supported the first assumption of the optimal-complexity model, i.e., the critical importance of stimulus complexity.

[13]The constructs *objective* and *subjective complexity* are borrowed and adapted from Hargreaves (1986, pp. 116–117).

The second general assumption of the optimal-complexity model, that the relationship between complexity and affective value may be described by an inverted U-shaped curve, suggests that a person will like more, prefer more, or be more pleased by music at an optimal-complexity level (i.e., moderately complex) for him or her than by music that is either very simple or very complex. Research testing this assumption includes both studies that attempt to vary the objective complexity (information or redundancy) and studies that use subjective complexity (perceived or judged complexity).

Research examining the effects of both types of complexity generally supports the inverted U-shaped curve hypothesis. Smith and Cuddy (1986) cite five studies using tone sequences with varied information content (i.e., complexity) as the independent variable that support the inverted U-shaped curve hypothesis (Berlyne, 1971; Crozier, 1974; Vitz, 1966a, 1966b; Walker, 1981). However, they also cite studies showing positive linear (monotonic) relationships between amount of information and judged preference (Vitz, 1962, 1964).

Hargreaves' review of studies of subjective complexity and liking for musical excerpts similarly supports the hypothesis. He notes the Crozier (1974) and McMullen and Arnold (1976) studies cited above, as well as some of the studies cited by Smith and Cuddy. Other studies cited as supportive of the inverted U-shaped curve hypothesis include Heyduk (1975), Radocy (1982), and Hargreaves and Castell (1986).

Heyduk (1975) varied the harmonic and rhythmic content of four brief piano compositions so that they reflected different levels of objective complexity. Subjects' "liking" ratings of the resultant versions of varying objective complexity provided strong support for the inverted U-shaped curve hypothesis and the general assumptions of the optimal-complexity model.

Radocy (1982) tested Walker's (1981) version of the optimal-complexity nodel, the "hedgehog" theory, so-named because Walker views the theory's one central idea as being applicable to many situations, just as the European hedgehog has one response to fatigue, stimulation, or fright, namely rolling into a ball. Using 15 instrumental excerpts from Western art music as stimuli, Radocy asked college music and nonmusic majors to rate each excerpt in terms of complexity, familiarity, and preference. Results revealed that excerpts rated as moderately complex were the most preferred, despite a strong positive linear relationship between familiarity and preference. He concluded that perceived complexity or lack thereof is more than just a matter of familiarity.

Hargreaves and Castell (1986) compared the preferences of subjects of different age levels, which presumably reflected different levels of musical enculturation, for four types of melodic sequences, ranging from very familiar melodies to "near" and "far" statistical approximations of music. Ratings

of the familiar melodies and the unfamiliar folk song melodies yielded inverted U-shaped relationships with increasing age, but with a later peak for the unfamiliar melodies. The statistical approximations to music were preferred less as the subjects' ages increased. Data were interpreted as supporting the inverted U-shaped curve hypothesis, as well as Hargreaves' contention that *stimulus familiarity* serves as a key explanatory variable in tests of the optimal-complexity model.

Although research generally supports the theory's assumption that complexity and affective value may be described by an inverted U-shaped curve, the role of familiarity is less clear. Research related to the theory's third assumption, that repeated exposure to a stimulus (i.e., increasing familiarity) serves to lower stimulus complexity, has yielded contradictory results.

Hargreaves' (1984) study of the effects of repetition on "liking" of music examined the hypothesis that the liking curve would, with repeated listening, reflect an inverted U-shaped curve. Using musical pieces in four styles, he conducted two experiments, one with adults and one with university students, in which subjects rated the pieces on seven-point scales for liking and familiarity. Excerpts for the adult group were played three times, those for the other group four times. For the adult group, which heard easy listening and avant-garde jazz excerpts, familiarity ratings increased with repetitions, but results differed for different styles. For the easy listening music, which appeared to be at about the listeners' optimal levels of subjective complexity, liking ratings declined with repetitions, but for the avant-garde music, which probably was above the listeners' initial optimal subjective complexity levels, the liking ratings increased with repetition. For the university students, who heard avant-garde jazz, pop, and classical excerpts, liking curves also varied with style. Ratings for the avant-garde excerpts did not change, but those for the pop and classical excerpts generally supported the inverted U-shaped curve. Apparently the inverted U-shaped curve predicts preference well within styles but not between styles. Perhaps optimal-complexity levels differ for different styles as a function of listeners' musical experience and expectations.

Smith and Cuddy (1986), whose study was discussed above in relation to the first assumption of the optimal-complexity model, also examined repetition effects. Their data revealed that for four of the five complexity levels, subjects' "pleasingness" ratings increased with repetition. However, on a post-repetition test, which contained some repeated sequences and some nonrepeated sequences, the repetition effects did not carry over, leading the authors to conclude that "the degree to which we appreciate repetition depends in part on the initially perceived complexity of the repeated excerpt" (p. 31). They suggest that "mere repetition does not necessarily lead to cognitive reorganisation; if it does not, the evaluation of rule complexity

will be unaffected by repetition" (p. 31).

Hargreaves' (1986, pp. 118–122) excellent review of the literature on repetition and liking led him to conclude that "the results of approximately half of the studies seems to support the inverted U-shaped hypothesis, whilst the other half show a positive monotonic 'mere exposure' relationship between familiarity and liking" (p. 119). He acknowledges that the contradictory results could be the result of differences in experimental designs and procedures, but he argues quite convincingly that they may be due to the variations in the ranges of the familiarity variable sampled in the experimental stimuli. He maintains that studies showing linear relationships between repetition and preference could just be sampling the beginning or ending part of the inverted U-shaped curve, depending on the initial stimulus complexity level for the subjects. He notes that this view is in accord with Lundin's (1967) earlier review of the repetition literature, which stated that popular music tended to attain a maximal pleasantness level at an early repetition, while classical excerpts, which presumably were more complex, reached their affective maximum during later repetitions. Smith and Cuddy's (1986) discussion of the research on repetition effects essentially concurs with Hargreaves' explanation for the seemingly contradictory results from repetition studies.

More recently, North and Hargreaves (1997, pp. 87–92) sought to clarify the seemingly contradictory finding of the literature regarding familiarity and the inverted U-shaped curve. Based on a review of research related to music in everyday life (radio plugging, preference-feedback, acculturation and familiarity, and complexity and tempo), they maintain that (a) at any given time there should be a positive relationship between liking and familiarity, but over time liking should wax and wane as a person chooses to (or not to) listen to given pieces or styles; (b) through acculturation some music becomes more familiar and predictable, thus less subjectively complex; and, consequently (c) for certain styles (e.g., rock and pop), liking peaks earlier in the life cycle than does liking for classical music. They conclude that studies of musical preference in everyday life seem to support the inverted U-shaped curve: "naturalistic exposure to real music is associated with liking for it in a way that is consistent with preference for moderately arousing stimuli" (p. 90).

As may be apparent, the experimental aesthetics approach to understanding the affective response to music has developed a workable research paradigm (the optimal-complexity model), which has generated considerable data. However, it also is apparent that the research paradigm needs refinements so that more consistent data might be forthcoming. While a number of factors may contribute to the inconsistent data, future research should scrutinize some of the variables very carefully. The research appears to be

overly dependent on verbal ratings as measures of liking, pleasingness, preferences, etc., with little consideration given to the reliability of such ratings. Certainly, the assumptions of the optimal-complexity model and the complex interrelationships among the collative variables warrant further careful examination. The examination of familiarity has been almost solely in terms of particular pieces, whereas Meyer's (1956, 1967, 2001) applications of information theory as a model for meaning in music, discussed in the next section, suggest that familiarity with style, idiom, or rules of musical grammar seems to be of even greater importance. The apparent relativistic nature of collative variables suggests that *individuals*, as well as groups, will differ greatly in their perception of and response to musical stimuli; consequently, there is a need for study of individual differences in addition to group differences, which have been researchers' primary concerns to date.

While discussions of cognitive and affective responses to music generally are separated for convenience, a need exists for more studies, such as Smith and Cuddy's (1986), which seek to examine both perceptual and cognitive underpinnings of affective behavior. Finally, researchers need to give greater consideration to the role of enculturation and the sociocultural context within which data are gathered. In short, major developments in experimental aesthetics have occurred during the past few decades, but refinement of research variables and methodology is still necessary if psychological aesthetics is to provide satisfactory answers for those seeking to understand the affective response to music.

Meaning in Music

As may be apparent from the preceding discussions, a broad gap exists between philosophical and psychological aesthetics. Philosophers tend to talk to philosophers, and psychologists tend to talk to psychologists. Philosophers tend to be concerned with whether music's value and import come from within the music or from its referents, while psychologists examine the affective response to music in terms of psychophysiological, verbal, or behavioral response to music. However, information theory, with its constructs related to redundancy, appears to offer a viable means for bridging the gap between aesthetic theory and musical response,[14] and Leonard B. Meyer's work toward this end provides some direction not only for philosophical and psychological aestheticians, but for anyone concerned with understanding the affective response to music.

Meyer (1956, pp. 1–42) espouses a theory of musical meaning based on a

[14]Besides the work of Berlyne and Crozier, Moles (1966) has conducted significant work. In addition, much of Roederer's (1995) work in the psychoacoustics of music, noted in Chapter 4, utilized information theory as a framework for examining response to aural stimuli.

theory of emotion and expectation. The relationships between his theory of musical meaning and information theory are explored in his *Music, the Arts, and Ideas* (Meyer, 1967). This section examines Meyer's theories of emotion and meaning in music as well as some of the parallels between his theories and information theory.

Meyer's theory of musical meaning is based on his *theory of emotion*, which has the same basic tenets as Dewey's *conflict theory of emotion*. "Emotion or affect is aroused when a tendency to respond is arrested or inhibited" (Meyer, 1956, p. 14). Emotional responses depend on the relationship between a stimulus (music) and a responding individual. Originally, the theory suggested that a musical stimulus must produce a tendency for an individual to respond in a particular way. A stimulus that arouses no tendency to respond or that is satisfied without delay can not arouse emotion.

Reimer and Wright (1992) note that Meyer subsequently revised his theory of musical meaning to recognize that a tendency to respond most likely is not limited to a single particular response, but results in a tendency to respond in terms of a weighted set of musically probable events. They describe the revision as it relates to information theory:

> The most probable event produces the least information; the most unlikely event produces the most information. Thus, Meyer's theory of musical meaning can be modified to this: musical meaning arises when a listener, uncertain of the music's progress, objectively or tacitly estimates the probabilities of the music's continuation. When less probable events occur, the music is experienced as meaningful or informative. To Meyer, music is as meaningful as it is informative. (Reimer & Wright, p. 214)

The most meaningful events are those that are neither so direct (highly probable) as to appear trite nor those that are so elusive (highly improbable) as to appear ridiculous to a listener knowledgeable of the musical style heard. This is somewhat analogous to the inverted U-shaped curve with respect to liking or pleasingness ratings and complexity.

Uncertainty relates to the intensity of emotional experiences, and, as Meyer (2001, p. 359) indicates, when the listener is able to maintain a certain sense of control and understanding–in Meyer's words, "to envisage with confidence"–the experiences are apt to be pleasant. Intense uncertainty, however, which hampers the ability to follow the music with confidence, results in unpleasant emotional experiences.

Meyer differentiates between emotion per se and the emotional experience: The latter includes an awareness and cognition of a stimulus situation that always involves specific stimuli. Thus, affective experiences with music require *musical* stimuli. However, as Meyer (2001, p. 348) indicates, not all emotional responses experienced with music are evoked directly by musical

stimuli as sound patterns. The music may make allusions to other compositions or cultural activities. There also is an idiosyncratic "nostalgia" emotion, which may be evoked by any sound.

Musical affective experience is distinguished from affective experience in everyday life. Tensions created by tendencies to respond in everyday life may go unresolved, whereas those aroused by music usually are resolved within a musical framework. Music can serve as both stimulus and as meaningful resolution to such tendencies; in life, that which creates the tension usually can not serve to resolve it.

Tensions, which may be either conscious or subconscious, are rooted in expectations. Music arouses expectations in various ways. Listeners to Western music *learn* (consciously or subconsciously) that certain "sound terms" (melodic, rhythmic, or harmonic patterns, phrases, etc.) imply certain other musical entities. When the expected musical consequent is delayed, suspense is aroused. In Meyer's (1956, p. 28) words,

> the greater the buildup of suspense, of tension, the greater the emotional release upon resolution. This observation points up the fact that in aesthetic experience emotional pattern must be considered not only in terms of tension itself but also in terms of the progression from tension to release. And the experience of suspense is aesthetically valueless unless it is followed by a release which is understandable in the given context.

A musical consequent that will fulfill such expectations is dictated by the possibilities and probabilities of the style of the musical composition in question. When seen in this light, stylistic knowledge becomes essential; without knowledge of a musical style or idiom, a listener's expectations lack a basis for focus, other than the unexpected.

In summary, Meyer's theory of emotion is a theory of expectation, which necessarily has certain cultural and stylistic presuppositions. His central hypothesis is that "affect or emotion felt is aroused when an expectation–a tendency to respond–activated by the musical stimulus situation, is temporarily inhibited or permanently blocked" (Meyer, 1956, p. 31). Without the essential expectations, affective possibilities are extremely limited.

For many, the question of musical meaning is centered on the opposing views of the absolutists and the referentialists, but much of the confusion results from different views regarding the definition of meaning. For Meyer, "Anything acquires meaning if it is connected with, or indicates, or refers to something beyond itself, so that its full nature points to and is revealed in that connection" (1956, p. 34). Meaning is defined in terms of the relationship between a stimulus and the thing it points to or indicates, but such a relationship must be perceived by the listener. Meaning thus arises out of a triadic relationship among (a) a stimulus, (b) that to which it points, and (c) the

conscious observer.

Meyer maintains that music's meaning has been further muddled by aestheticians' failure to state explicitly that to which musical stimuli point.[15] He recognizes two types of musical meaning: *designative* and *embodied.* The designative meaning of a musical stimulus may indicate events or consequents that differ from itself in kind, i.e., nonmusical events. Embodied meaning refers to events in which the stimulus and consequent are of the same kind, i.e., both musical. Designative meaning concerns that which music represents (a referential perspective), while embodied meaning concerns structural interrelationships within the music (somewhat akin to a formalist or absolute expressionist perspective). Meyer is far more concerned with embodied meaning. For him, one musical event has meaning because it points to and makes the listener expect another musical event. Embodied musical meaning, therefore, is a product of musical expectations, developed as a result of past experiences with music of a given style. Music that does not arouse expectations of a subsequent musical consequent is meaningless for the listener. Because expectation is so much a product of stylistic experience, music in a style with which a listener is totally unfamiliar usually holds little meaning for the listener.

Knowledge of style implies that learning has occurred; thus, the perception of meaning cannot occur without involving cognition. One can not separate the affective and intellectual responses to music. Both depend on the same perceptual processes, stylistic habits, and mode of mental organization. The same musical processes give rise and shape to both types of experience. Meyer maintains that the formalists' and expressionists' conceptions of aesthetic experience are complementary rather than contradictory. They are considered not different processes, but different ways of experiencing the same process. "Whether a piece of music gives rise to affective experience or to intellectual experience depends upon the disposition and training of the listener" (Meyer, 1956, p. 40).

People who have been taught that musical experience is primarily emotional probably will experience delay of expectation as affect. The trained musician probably will listen in more technical terms and tend to make musical processes an object of conscious consideration. Regardless of the way in which one views the delay of expectations, Meyer's theory of expectation may explain it.

[15]The meaning of *musical meaning* varies greatly among musicologists, aestheticians, and psychologists. The present discussion follows Meyer's classic theory of musical meaning. One could argue that functional music (discussed in Chapters 2 and 3) also is meaningful, though not in the philosophers' referential sense. It is functional, but not necessarily symbolic. Readers interested in exploring musical meaning from an ethnomusicological perspective should see Tolbert's (2001) enlightening discussion. Of course, many writings in philosophical aesthetics offer perspectives on musical meaning.

Meyer (1967, pp. 5–21) notes striking parallels between his theory of musical meaning and information theory and hypothesizes that "the psychostylistic conditions which give rise to musical meaning, whether affective or intellectual, are the same as those which communicate information" (1967, p. 5). Meyer specifically argues that it is music's embodied meaning that is most consistent with information theory.

As discussed in Chapter 6, information theory is a system for quantifying the amount of uncertainty in a stimulus. The greater the amount of *information,* the greater the *uncertainty* of meaning or response. The amount of information a listener receives from a musical stimulus is a function of two basic variables: (a) the extent to which the music's structural characteristics conform to fundamental organizational laws of Gestalt psychology and (b) the listener's previous experience with the given musical style. The greater the music's perceptual redundancy, the more predictable the musical response.[16]

Variables Contributing to Musical Meaning

Variables contributing to musical meaning may be classified under two broad categories: (a) those related to the structural (collative) characteristics of the musical stimulus and (b) those related to the listener, particularly the experiential variables. McMullen (1978) conveniently groups the variables related to musical structure under three headings: *order, complexity,* and *energy.*

He notes that order is closely related to a traditional aesthetic principle of "unity in variety." Order within musical structure appears a function of a composition's structural redundancy; e.g., tonality and rhythmic redundancy appear to contribute greatly to musical meaning, but until recent years researchers gave little attention to systematic investigation of the effects of order in musical structure.

Complexity of musical structure, a construct related to order, currently receives much attention from psychological aestheticians, although much of the research examines it as a perceived or subjective variable rather than as an objective structural attribute of music. As discussed previously, the authors believe that complexity, as all collative variables, is relativistic, and that responses to complexity result from interactions between the music's structural attributes and the listener's prior experience with music in general, the given musical style and/or idiom, and the particular music heard. However examined, structural complexity is a critical variable in a musical response, as demonstrated by its centrality to the optimal-complexity model of musical preference.

[16]The relationship of perceptual redundancy to *structural* and *cultural* redundancy is discussed in Chapter 6.

Energy is the quality that a listener generally perceives as stimulation, intensity, or excitement. Variables such as tempo and dynamics generally are recognized as primary contributors to energy, but other variables such as melodic and harmonic movement also appear to contribute.

Some of the early work regarding mood response, as reported by Lundin (1967, pp. 160–177) and Farnsworth (1969, pp. 83–90), examined some of the musical (psychoacoustical) variables underlying order, complexity, and energy. Also, much of the research in experimental aesthetics reviewed by Hargreaves and his colleagues (Hargreaves, 1982, 1984, 1986; Hargreaves & Coleman, 1981; North & Hargreaves, 1997; Sluckin, Hargreaves, & Coleman, 1982) has a direct bearing on relationships between complexity or energy and liking.

McMullen (1980, 1982a, 1996) suggests that people's connotative verbal descriptions of music, traditionally mood response as indicated by adjective descriptors, have taken on greater import as reflections of musical meaning. He maintains that rather than just connoting some mood or other meaning external to the musical stimulus, the connotative labels (adjective descriptors) provide evidence for an *interpretive paradigm*, as indicated by studies of dimensionality. The proposed paradigm is relativistic and differs from the predominant psychoacoustical paradigm, which considers music and its attributes external to and independent of human subjectivity.[17] "When the human mind interprets these properties as meaningful, only then can an affective response be considered" (McMullen, 1996, p. 389).

McMullen (1996, pp. 392–394) subsequently offers a two-dimensional "framework of affective/aesthetic responses," derived primarily from dimensional research, which suggests that the listener experiences the perceived dimensions of *energy* and *structure* as forms of *activation*. As activation (the horizontal dimension of McMullen's model) increases to an intermediate level, an optimum positive level of acceptance is attained on the rejection-acceptance/evaluation continuum (the vertical dimension). In short, he argues that activation and evaluation interact in determining the *meaning* of a given connotative word. As may be apparent, this interaction may be reflected by an inverted U-shaped curve. Also, it is consistent with Meyer's theory of musical meaning.

Contemporary research continues to examine the effects of various musical attributes (psychoacoustical variables) on listeners' responses. While variously called affective or emotional responses, they essentially reflect attributes that contribute to the activation dimension of McMullen's model. If one accepts the premise of an interactive paradigm, much of this research could

[17]Strictly speaking, "psychoacoustical" phenomena are the result of human processing of acoustic stimuli; they inevitably are "subjective" as they result from the actions of a human subject. "Acoustic paradigm" may be a more appropriate label.

be considered relevant to the construct of musical meaning. Some recent studies that might be interpreted via McMullen's paradigm of musical meaning include Juslin and Madison (1999)–timing patterns; Kamenetsky, Hill, and Trehub (1997)–tempo and dynamics; Kaminska and Woolf (2000)–melodic line; Laukka and Gabrielsson (2000)–tempo, dynamics and timing; Pressnitzer, McAdams, Winsberg, and Fineberg (2000)–timbre and psychoacoustical roughness; and Schellenberg, Krysciak, and Campbell (2000)–pitch and rhythm. Obviously, the time is right for a major meta-analysis of research related to musical structure and affective meaning.

Variables related to the listener also are many and complex. Abeles and Chung (1996, pp. 286–342) group listener variables or characteristics into two broad categories: *short-term* and *long-term*. Short-term characteristics might include existing mood, physical and mental alertness, interest, and attention level, while long-term characteristics include such attributes as general intelligence, personality, age, gender, race, musical experience and training, and a wide range of social factors. Perhaps of greatest importance are the variables related to the listeners' previous experiences with music. From infancy on, individuals have many experiences with music. They develop expectations regarding its structure (embodied meaning) as well as its referents (designative meaning). In addition to expectations, formal musical training, and the resultant ancillary learning, variables affecting musical learning include associations with particular musical examples and styles, as well as all of an individual's informal musical experiences.

In conclusion, previous researchers' efforts to examine the effects of selected variables merit considerable acknowledgement: They have contributed much to the understanding of musical meaning. However, research related to musical meaning or the affective response too often is fragmented or conducted in isolation. Much collaborative research integrating the diverse effects and approaches toward examining the effects of the variables noted here (as well as many others) is necessary before any "final truth" is reached regarding affective responses to music.

Summary

1. *Affect* is a broad term referring to a wide variety of human feeling responses.
2. *Emotion* is a particular type of affect reflecting a relatively temporary disturbance from a normal state of composure.
3. *Aesthetic* feeling results from certain types of experiences with art works, natural phenomena, or other objects or events in which one may perceive beauty, artistic value, or meaning.
4. *Aesthetic experience* requires perceptual involvement with interacting

attributes within art works (or natural phenomena or other objects or events), perception of beauty or meaning therein, and a feeling reaction thereto; it is more than just "oh how pretty."

5. Other types of affective responses to musical stimuli (besides the aesthetic) include mood or character responses, association responses, intrasubjective responses, reactions to word meanings of songs, preferences, interests, attitudes, values, and appreciations.
6. Four basic approaches to study of the affective response to music include (a) psychophysiological research, (b) adjective descriptor research, (c) philosophical inquiry, and (d) psychological aesthetics research.
7. Concomitant with affective responses are physiological reactions of the autonomic nervous system.
8. Although physiological reactions to music, particularly heart rate, respiration rate, and electrodermal responses, have been examined for over a century, such research provides little insight into the affective response to music.
9. Early research using adjective descriptors focused on assessing mood response to music, but more recent research using dimensional analysis techniques on semantic differential data has sparked a renewed interest in adjective descriptors as tools for understanding affective behaviors.
10. Speculative aesthetics is of two basic types: *philosophical aesthetics,* which seeks to make general statements regarding arts phenomena and their intent, value, or meaning, and *art theory,* which in music is incorporated in such courses as music history, literature, and analysis, and which involves examination of individual compositions, styles, and composers.
11. Basic philosophical aesthetic positions include the *absolutist,* which views the value or meaning of music as resulting from the musical sounds themselves, and the *referentialist,* which views music as reflecting more than sounds themselves; the referentialist position may include extramusical ideas, emotions, stories, and even spiritual states.
12. Psychological aesthetics, particularly with the renewed emphasis on *experimental aesthetics,* utilizing methods of empirical science, focuses on the collative properties of aesthetic stimuli, examines motivational questions, studies nonverbal as well as verbal behavior, and seeks to establish links between aesthetic and other psychological phenomena.
13. Research in psychological aesthetics has focused on the optimal-complexity model of music preference, in which an individual's "liking," "pleasingness," or "preference" response to a musical stimulus hypothetically reflects an inverted U-shaped curve with respect to complexity.
14. The collative variables of a musical stimulus (complexity, novelty/familiarity, uncertainty/redundancy) are relativistic.
15. An apparent parallel exists between Leonard B. Meyer's theory of musical meaning, which views meaning in terms of expectations, and information theory, which offers a promising model for examining affect resulting from musical uncertainty.
16. Broadly classified, variables contributing to musical meaning relate to (a) the structural (collative) characteristics of a musical stimulus and (b) the listener, particularly the experiential variables.

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Chapter 9

MUSICAL PREFERENCES

People vary in their preferences for any sensory experience in which they have a choice. Personal preferences for certain foods, paintings, home decor, clothing, and music are rooted in individual biological needs, cultures, training, and experience. Preferences are not always consistent, and they can be modified. What is preferred in one instance is not necessarily preferred in another.

People may use *preference* and *taste* interchangeably; occasionally the terms are distinguished on the basis of commitment. Abeles (1980, p. 106) suggests that taste implies a relatively long-term value for or commitment to a broad class of objects or events, while preference implies a more immediate and specific choice within a set of possibilities. One might have a taste for white wines or romantic orchestral music and preferences for a particular rhine or chablis, or particular works of Liszt or Strauss. The difference between preference and taste may be a matter of perspective, and, while semantically interesting, probably is of little consequence in studying factors which influence making musical choices.

Musical preference is an area of longstanding interest in the psychology of music, although in some ways preference may be subsumed within aesthetics. What factors influence musical evaluations and decisionmaking are of continuing concern to composers, performers, orchestra managers, advertisers, entertainers, and others who may have a vested interest in people's musical interests. A simple preference of one musical work over another may have meaning beyond the musical decision. Psychologists may use expressed musical preferences to assess personality via deviations from population trends regarding musical choices. Half a century ago, Cattell and Anderson (1953) indicated that "aesthetic" reactions could differentiate psychotics and paranoids from "normals," and alcoholics with psychoses from other psychotics. Hahn (1954) found that individual musical choices reflected clinical personality assessments. Choices also depended on aesthetic values and individual needs for sensual pleasure. Researchers often explore relationships between and among various aspects of personality and musical preferences. Payne (1980) found that among trained musicians, extroverts had a greater preference for "emotional" music while introverts had a greater preference

for music with a more "formal" structure. Glasgow, Cartier, and Wilson (1985) found "conservative" listeners preferring familiar rather than unfamiliar classical music to a greater extent than "liberal" listeners. Dollinger (1993) found that extroversion related positively to preference for hard rock. He also found that people's openness to diverse experiences related to their enjoyment of musical styles other than popular music. Rawlings, Dodge, Sherr, & Dempsey (1995) found that a personality factor called "toughmindedness" or "psychoticism" (Eysenck & Eysenck, 1976) relates to a preference for hard rock music and dissonant sounds. The relationship of personality and musical preference is tenuous due to idiosyncratic behavior.

This chapter examines determining what is "good" music, particular preferences, various musical, psychological, and social influences on preference, and alteration of preference.

What Is "Good" Music?

What music is "good" is, of course, a matter of judgment. Reasons for individuals judging particular music as superior to other music may include musical characteristics, such as forms, tempos, orchestral colors, and lyrics. Extramusical associations ("Darling, our song . . .") and societal pressures may be influential. Preferences may be based on simple enjoyment, fervent intellectualization, or ideas of what one "ought" to prefer. Group preference tendencies exist; they are not solely a matter of individual choices. Group tendencies may arouse concern for what good music really is–what *should* be preferred?

One traditional view of "good" music is that that which is good is good because of inherent aspects of the musical stimulus. In such a view, melodic, harmonic, and formal ideals characterize good, even great music. If the listener is educated properly in such ideals, his or her preferences will conform to some aesthetic ideal. The view that good music owes its goodness to its structure represents a *formalistic* (Meyer, 1956; Reimer, 1989) or *isolationist* (Schwadron, 1967) position regarding musical aesthetics. The music's value supposedly is inherent in the music itself.[1]

Music, indeed all art, has properties that arouse people. The so-called "collative" variables of novelty, surprise, complexity, and ambiguity, related to form and structure, influence the observer's response. Instability can lead to discomfort; incongruity may increase attention (Berlyne, 1971). The essence of Meyer's (1956) theory regarding musical enjoyment, discussed earlier, is that the delay of musical expectancy promotes pleasure through

[1]Hanslick's 1854 view that the real music is contained in a musical score and can be only approximated in any audible performance represents an extreme formalist position, with philosophical roots in Plato. For a discussion, see Higgins (1991, pp. 20–35).

the ultimate dissipation of the resulting frustration. Complex music, as long as it is not *too* complex, is more likely than simpler music to be preferred over a longer period. McMullen and Arnold (1976) showed a tentative relationship between rhythmic redundancy and preference; the less the dominance of one rhythmic figure, the less the redundancy and the greater the preference, to a certain point.[2]

If music's inherent or "objective" structure is of particular importance, then Adorno's (1976) oft-cited hierarchy of listeners has particular implications. His hierarchy suggests that structural awareness is of the greatest importance in serious listening; his highest classification is the *expert,* who can hear musical structures completely and properly order all formal nuances. The hierarchy then runs "down" through a *good listener,* who hears beyond musical details but lacks structural awareness, a *culture consumer,* mainly concerned with information about music, a nonintellectual *emotional listener,* a *protest listener,* an *entertainment listener,* and, finally, an *indifferent, unmusical,* or *antimusical listener.* Adorno believes that music primarily is an intellectual event, although he does state that one must understand music's social characteristics in order to understand music.

In contrast to the view that good music is "good" because of its structure is a view that preferred music is preferred because of its individual values and utilities rather than any inherent goodness. Whereas Adorno indicates that a criterion of individual taste would deprive "great" music of what makes it great, Chancellor (1974/1975) says that all art is ambiguous and acquires its values from subjective, pluralistic, and relativistic determinants. Hamm, Nettl, and Byrnside (1975) tie music to society and culture and allow for individual utility and personal gratification. Meyer (2001), while clearly maintaining his belief in the importance of musical structure and tension-release evolving from structural intricacies, recognizes that emotional responses, which need not be evoked by the sounds themselves, are an important part of a musical experience. In its extreme the view that music is meaningless except to the extent that it communicates extramusical messages is a *referential* (Meyer, 1956; Reimer, 1989) or a *contextual* (Schwadron, 1967) position. A school of aesthetic *relativism* (Schwadron) allows for different value systems for different musical styles and recognizes the importance of musical structure while allowing for cultural and functional variability in musical preference.

In recent years, some people have questioned the concept of the musical "work" as an entity; this may have implications for attributing music's

[2]Much contemporary (2002) popular music suggests that considerable amounts of rhythmic redundancy are desirable, at least in music popular for short periods of time. The music often has a dominant syncopated or anapestic accompanying figure (zoom POW zoom POW) that is louder than the melodic line and helps obscure the lyrics.

"goodness" to structure or any personal meaning independently of performance. In a major contribution to music education philosophy and by extension to psychological aspects of musical preference, Elliott (1995) advanced a "praxial" philosophy in which musical procedures–the active making of music through musical actions–are of prime importance. Elliott uses "music" as a verb; one "musics" when he or she performs, listens, composes, arranges, or conducts. One is engaged in "musicing" as one "musics."

Similarly, Small (1998) finds fault with the concept of a musical work: Music is an activity (Small uses the term "musicking"); it is not a static thing. Making a "work" out of music deemphasizes performers, who then become only a means to an end, a one-way communication medium between composer and audience. Beauty in a performance is not limited to "good" musical "works"; music should not be divorced from its religious, political, or social contexts. Three quotes succinctly make Small's points: "The fundamental nature and meaning of music lie not in objects, not in musical works at all, but in action, in what people do" (p. 8). *"To music is to take part, in any capacity, in a musical performance, whether by performing, by listening, by rehearsing or practicing, by providing material for performance (what is called composition), or by dancing"* [ital. in original] (p. 9).

> It is not enough to ask, *What is the nature or the meaning of this work of music?* . . . Using the concept of musicking as a human encounter, we can ask the wider and more interesting question: *What does it mean when this performance (of this work) takes place at this time, in this place, with these participants?* [ital. in original] (p. 11)

From Elliott's and Small's arguments, one can build a case for "good" music acquiring its "goodness" from its interactions and functions. Structure and extra-musical aspects may be a part, but the goodness must arise in a broad context of active musicmaking.

Indeed, individual critics, musicians, and listeners may continue to explain musical preferences on the basis of inherent musical properties. (In a strongly worded review, Reimer (1996) found Elliott's emphasis on performance "dangerous.") Nevertheless, it may be more fruitful psychologically to study preference in terms of people's expressions of preference, which may be inextricably intertwined with performance. "Good" music is good because people *desire* it, due to their moods, backgrounds, training, experiences, prejudices, and beliefs. Some people want complexity. Some want simplicity. Some want strong narrative suggestions; some want an exercise in tracking and labelling musical form. Some preferences are predictable; others are not. A strong performance may enhance the reaction to rather ordinary music; a weak performance may denigrate "great" music. It depends on

the person making the choice.

Existing Musical Preferences

No formula exists for predicting individual musical preferences reliably, although particular groups tend to prefer particular musical styles. Many investigations are directed toward preferences for Western art ("classical") music. Small (1998, pp. 3–4) notes that classical music has a puzzling status: The music is held in high esteem, even regarded as the "essence" of music, yet it is truly "popular" with a very small group of people. Often, investigations rely on polling of representative groups and archival records (e.g., printed programs) of what is performed. A few studies have related listener characteristics to musical preferences.

Any measure of musical preference is imperfect. People may not respond honestly to questions regarding their preferences; reasons for attending live performances selectively include nonmusical ones, such as social visibility. Examining collections of recordings may be useful, but individuals vary in the extent to which they can afford an extensive collection, and possessing a recording tells little about how often the owner listens to it. Ever greater amounts of listening may occur on the Internet. Analyses of what is performed, broadcast, or downloaded are subject to biases of conductors, wealthy patrons, industry executives, and advertisers. Scholarly discussions of music reflect musical preferences, but with editorial biases.

Regardless of what a listener bases a musical preference judgment upon, the judgment represents a subjective impression of musical desirability. As with sensory impressions, magnitude estimation, i.e., measurement by matching one sensory continuum with another (often numbers, but not necessarily so) is a viable technique if one is willing to accept matching impressions as measurement (Radocy, 1986). Aesthetic judgments may be prothetic in nature; investigators have observed psychophysical phenomena, such as a tendency to hear the second member of a pair of ambiguous stimuli as having "more" of the property in question, in affective measurement (Koh, 1965, 1967). Perhaps magnitude estimation or some other technique which does not require counting units may enable quantification of preferences in a meaningful way.

Summaries of some representative investigations of preference follow.

Surveys and Classical Music Preferences

Just as rock and roll was becoming nationally popular, Keston and Pinto (1955) investigated college students' musical preferences. They found that students with greater amounts of musical training and experience who were willing to spend the time required for concentrated listening tended to prefer classical music over "pop concert," "dinner," or currently popular music. The evidence was correlational; neither musical training nor any other variable "caused" the preference for classical music.

Farnsworth's (1966) eminence rankings are milestones in the study of preference for art music and changes across time. Based on polls of American Musicological Society members in 1938, 1944, 1951, and 1964, the rankings list composers in order of their perceived eminence. "Eminence" means perceived contributions to music history and worthiness of study. In the final year, the "top five" composers in order were Bach, Beethoven, Mozart, Haydn, and Brahms. The rankings were relatively stable across the sampling years, and they always showed a relative absence of twentieth-century composers. The American Musicological Society hardly is representative of typical listeners, and one could criticize Farnsworth's polls because of lack of currency, disproportionate attention to European composers, and possible inconsistency in exactly what the respondents evaluated, but the rankings do suggest that musical preferences within one style have some degree of consistency–they are not solely a matter of whimsy. Of course, eminence and preference are not identical. Farnsworth (1969, p. 110) reports polls showing less than perfect relationships between perceived eminence and enjoyment of particular composers. On one occasion, expressed preference may be based on eminence; on another, it may be based on enjoyment.

Poland (1970) conducted a content analysis of three music history texts, two music theory texts, Farnsworth's rankings, and the then most recent issue of the Schwann catalog.[3] The 30 composers cited most frequently in each text, Farnsworth's top 30 names, and the 30 composers receiving the most space in Schwann overlapped considerably: Although the seven sources theoretically could yield 210 names, only 71 names appeared, thereby indicating considerable agreement among the various authors, Farnsworth's respondents, and the recording industry regarding whose music merits attention.

Poland then counted the total number of citations for each of the 71 composers in the combined five texts and listed the 60 composers who had at least one full column of Schwann listings. While not identical, the two lists contained remarkable similarities regarding composer nationality and historical period. About 59 percent of the combined citations were of works by German[4] composers. Ten percent were of French works, 9 percent were Russian, 7 percent were Italian, and slightly less than 3 percent were American. The remaining 12 percent accounted for the rest of the world, and all of those citations were to Europeans, except for the Brazilian Villa-Lobos

[3]The Schwann catalogs list available recordings of classical music by composer and title. The relative amounts of space required to list the works of various composers provide some indication of those composers' popularities as indicated by the marketplace.

[4]Austrian composers were considered German, probably for linguistic reasons.

Analysis of historical periods represented by Poland's combined citations showed that 19 percent were baroque, 26 percent were classical, and 34 percent were romantic. The text list showed 0.3 percent of the nonoverlapping citations for the years 500 BC to 1540, 3.8 percent for the renaissance, and 17 percent for a "modern" (1915–1955) period. The corresponding Schwann percentages were zero, zero, and 20.

Perhaps most reassuring or discouraging, depending on one's viewpoint, 52 percent of the text citations were to just 11 composers, nine of whom were German. Just five composers had one-third of all the citations; in order, they were Beethoven, Bach, Mozart, Brahms, and Haydn. (Although in a different order, these five Germanic composers were Farnsworth's top five.) Poland's investigation suggested that the core of formal collegiate musical study was built around works of "the three Bs" plus Mozart and Haydn. Perhaps preferences are perpetuated. Poland's study now is over three decades old, and the last part of the twentieth century saw increasing concern for multiculturalism and a quantum leap in recording technology. Older texts were rewritten and new ones appeared. The results of such a study at the dawn of the twenty-first century undoubtedly would vary from Poland's—but not much!

The apparent reverence for the past that emerges from descriptive research such as that of Farnsworth and Poland as well as in analyses of orchestral programs may trouble advocates of contemporary art music. People wonder whether a "gap" exists between contemporary composers and their prospective audiences and to what it might be attributable.

J. Mueller (1967) believed that an "aesthetic gap" indeed separated twentieth-century composers and audiences to an extent unseen earlier in music history. Favorable initial criticism of works of Beethoven and others and the rate of new works' appearances in nineteenth-century European concert programs suggest that the claim that "good" music never is appreciated initially just is not substantiated. Mueller noted that new music never is equally "new"; novelties vary in their public interest and adoption. The contemporary composer often is experimental and pays a price through nonconformity which strains an audience's ears and lacks perceptual redundancy. Mueller suggested that composers need to make more effort to understand their audiences.

Although inherent musical properties do not guarantee "good," "great," or "truthful" music, many people may prefer the lyric melodies, relatively predictable tonal and harmonic patterns, symmetric rhythms, extensive repetitions, and orchestral colors available in the music of eighteenth- and nineteenth-century composers. The widespread availability of recordings of many styles and eras means that twentieth- and twenty-first-century composers had to and have to compete with the music of previous generations (Hamm, Nettl, & Byrnside, 1975).

Popular Music

In general, investigators have not assessed preferences for popular music to the degree they deserve. Zillman and Gan (1997, pp. 182–183) express concern that social psychology has not paid sufficient attention to popular music when it is such a force in adolescent social development. Popular music appeals to many cultures and subcultures, but a view that popular music appeals to some broad undifferentiated mass, victimized by an inferior culture, is just not true. All people have specific and individual tastes (Denisoff, 1976). With the onset of television (which radically altered network radio), development of FM broadcasting, changes in recording technology, and the rise of an affluent youth culture in the United States and succeeding cultures since, radio stations developed numerous formats centered on various musical styles, several of which could be called "popular," as a way of marketing audiences to advertisers. The ability to download vast amounts of music from the Internet may permit even greater individuality of tastes; yet, music's social functions virtually assure some commonality of popular music preferences within various subcultures.

In the United States, and by extension to much of the world, the development of separate popular cultures has many implications for musical preferences. From roughly 1930 until the early 1950s, popular music was aimed predominantly at an adult, white, middle class structure. Music popular with one generation generally was popular with another. Country, African-American, and folk styles were alive and well, but they had largely a regional appeal. After about 1955, popular music became extensively fragmented, with each style having its own values and sociological bases. Country, soul, and folk styles acquired national audiences; rock music became the predominant music of youth (Frith, 1981; Hamm, Nettl, & Byrnside, 1975). Today, audiences exist for numerous styles, often with confusing and conflicting labels. In a survey of the then existing radio formats, Barnes (1988) identified the following music-based styles, many of which (but not all) represent a type of popular music: adult contemporary (basically rock but not "hard" rock), album-oriented rock (a bit "wilder"), beautiful music, big band, contemporary hit radio (a melange of basically rock-like styles), classical, contemporary Christian radio, country, easy listening, gold (basically older rock music), Hispanic, jazz (rare), "music of your life" (essentially from the one-dominant-style pre-rock period), new age, nostalgia, quiet storm (a format aimed at primarily African-American audiences), and urban contemporary. "Alternative" rock is a force in some areas.[5]

[5]Labels attached to musical styles may be quite confusing. One can gain thorough familiarity with a style only be listening to it, and styles constantly evolve, as do their labels. Consequently, any documentation of stylistic categories is open to interpretation.

Popular music does not lack aesthetic bases. Frith (1987) indicates that popular music fulfills four social functions: It helps individuals in self-identity, relates public and private emotional lives, shapes popular memory and sense of time, and becomes something possessed, as in members of a group proclaiming "this is *our* music." Four aesthetic factors enable fulfillment of the social functions. One factor is popular music's "intentional" complexity, due to manipulation of individual sounds within simple forms, rather than the "extensional" complexity of art music, due to extension of basic themes through various compositional devices such as augmentation, variation, and counterpoint. Another is use of the voice as an expressive instrument, beyond any particular words. A third factor is the possibility of analyzing and classifying popular music into ideological categories; a fourth, which, of course, exists for art music as well, is the association of particular sounds with particular times and places.

Within popular styles, preferences may change quite rapidly. A somewhat different phenomenon is the convergence toward one popular style within a particular group. In visiting American music classrooms, the authors have noticed that overall group music preferences narrow with increasing grade level. First, second, and third graders generally will listen to brief excerpts of a variety of musical styles without undue protest. The children accept the sound of a trained soprano, ethnic musics, and ambiguous electronic sounds. In fourth grade and beyond, students often will cover their ears, cringe, and look around to ascertain that sufficient numbers of peers are doing the same thing. The preferred music becomes rock or, occasionally, country.

About 30 years ago, studies by Greer, Dorow, and Hanser (1973), Greer, Dorow, Wachhaus, and White (1973), and Greer, Dorow, and Randall (1974) showed decreasing interest in nonrock music with advancing grade level. Assessments of attitudes toward music conducted as part of the National Assessment of Educational Progress showed increasing rock preferences with increasing age. Later, LeBlanc (1991), borrowing the term from Hargreaves (1982), hypothesized an *open-earedness,* a condition wherein young listeners have strong overall musical preference, a preference that declines with the onset of adolescence, broadens again with the onset of adulthood, and declines in the elder years. Later research (LeBlanc, Jin, Chen-Hafteck, Oliviera, Oosthuysen, & Tafuri, in press; LeBlanc, Jin, Simpson, & Stamou, 1998) supported the hypothesis. More extensive studies, with consideration of location as well as grade and age, are needed to assess the extent to which any style dominates today, especially given the diversity of available styles.

Summary of Existing Preferences

Existing preferences for Western art ("classical") music show a strong tendency to prefer music of the eighteenth and nineteenth centuries. Such preferences may result from contemporary composers' excessive deviations from compositional norms as well as from listeners' personal qualities. Popular music requires further investigation, although American popular music clearly is "popular" over much of the world. In the later elementary school years, as American students approach adolescence, preferences appear to converge toward rock or country music, which may make comprehensive education in a variety of musical styles difficult. Adults may broaden their tastes until their later years.

Influences on Musical Preferences

Musical preferences are more than an interaction of inherent musical characteristics and individual psychological and social variables. Societal pressures influence preferences. A person making a musical choice considers opinions of others who are significant in his or her life, as well as cultural messages in and about the music. Research suggests teacher approval influences on elementary school students' expressed preferences (Dorow, 1977; Greer, Dorow, & Hanser, 1973), altering preferences by associating music with Nazi Germany (Rigg, 1948), and adolescents expressing preferences to conform to those of influential peers (Inglefield, 1974; Johnstone & Katz, 1957). Of course, public expression of a view in accordance with that of an authority figure, peer leader, or perceived acceptable sentiment does not necessarily mean private belief.

After an extensive review of the then existing literature, Abeles (1980) concluded that personality factors and emotional states are related to preference, but not unambiguously. Gender had no consistent influence on preferences, although women generally had a greater long-term commitment to "classical" music. Racial differences in taste existed, and social class and political views might interact to influence taste. Clearly, repetition could influence preference. Although no "standardized" taste existed, mass media, peer groups, and musical experience all might influence taste.

North and Hargreaves (1997), taking a theory-based approach to evaluations of musical preference decisions in everyday life, describe numerous instances of interactions between the listening context and the music. Variations occur in the degree of desirable musical complexity, in the appropriateness of particular music for particular occasions, and in the way one's attitude toward music may be a function of the conditions under which it is experienced and vice versa. Clearly, any consideration of influences on musical preferences must recognize interactions among musical and environmental variables.

For over two decades, Albert LeBlanc's work has been highly influential in the study of musical preferences, largely because of his recognition of the importance of interactions among musical and environmental variables. His

model of the sources of variation in musical preference and taste and the supporting research he and his colleagues have conducted are major contributions to the psychology of music and music education, and the authors have elected to give detailed attention to his model and related research.

The comprehensive hierarchical model (LeBlanc, 1980, 1982) encompasses variables which influence the listener as well as variables which result from the listener's actions in making preferential judgments. While the model does not predict what judgment any particular listener will make regarding a piece of music, it is quite useful in detailing many of the processes that comprise a preference judgment.

The model's "bottom" level includes nine classes of input variables that characterize the situation in which the listener experiences the music. Four classes are primarily properties of the musical stimulus: physical (acoustical) properties, complexity, referential meaning, and performance quality. Peer group, family, educators/authority figures, and incidental conditioning are classes of environmental variables. The media comprise the remaining class of input variables. The input variables' relative importance will vary with individuals; the model does not suggest that any one variable class is more or less important than any other.

The input variables and interactions among them lead into LeBlanc's seventh level, physiological enabling conditions. The listener's auditory pathway must be able to receive the musical input, his or her brain must recognize pertinent extramusical variables as relevant to the music, and he or she must be sufficiently free from pain or other physiological emergency.

A listener experiences the input variables to the extent that physiological enabling conditions permit. However, without basic attention, LeBlanc's sixth level, no further meaningful musical awareness or judgment can occur. Thus, this level is a "gate": If the "gate" is closed, the music is largely meaningless. Whether or not to give "basic" attention to a stimulus is a conscious choice. The most elegant lesson in music appreciation goes for naught if the listener, for whatever reason, elects not to give the music attention.[6]

At the fifth level, the listener's current affective state "filters" the musical input to which the listener has elected to give basic attention. The individual's mood will influence his or her further musical processing and judgments. For example, "happy" music usually will interact differently with a "sad" mood than will "sad" music.[7]

Since background music technically is intended to be heard *"but not actively or purposely listened to"* Mussulman, 1974, p. 93; italics added), LeBlanc's model can not apply to true background music. f the listener gives conscious attention to what is intended as background music, the ersatz background music is failing in its function.

This by no means reduces music's potential to alter a mood. The current affective state may change s the listener experiences the music.

Auditory sensitivity (meaning sensitivity to particular aspects of musical sounds, not hearing acuity, perception, or reception), musical ability and training, personality, gender, ethnic group, socioeconomic status, maturity, and memory are relatively stable personal characteristics which characterize LeBlanc's fourth level. (Given discovery of significant effects for the listener's country in international preference studies, LeBlanc, Fung, Boal-Palheiros, Burt-Rider, Ogawa, Oliviera, and Stamou (2002) suggest that perhaps the model should add a country or culture variable.) A person may be especially sensitive to phrasing, particular timbres, or rhythms, perhaps overly so in relation to other aspects. Performance skill on a particular instrument may sensitize the listener to literature featuring that instrument; an experienced French horn player certainly has a different sensitivity to Strauss's *Till Eulenspiegel* or the Mozart horn concerti than a listener who is unfamiliar with the horn. Remembering what was heard formerly as a guide to what one is hearing now can be crucial for organization.

So, input variables characterizing the listening experience comprise a musical stimulus. The listener attends to that stimulus to the extent that he or she is physiologically able and personally willing. After interaction with the current affective state, the musical input is influenced by personal characteristics and interactions among them. Now comes a change from variables that influence the listener to variables that result from the listener's actions.

The change occurs at the model's level three, where the listener actively *processes* the input. Processing may include labelling stimulus aspects, such as the formal sections, instruments, style, and likely composer. The listener may consider extramusical aspects, including images of what the music may "say" or "mean." He or she may establish musical expectancies, which then are confirmed or disconfirmed.

After actively processing the input at the third level, the listener makes a decision at the second level: He or she either decides that a judgment is possible or that more information is necessary. If more information is desired, the listener explores the musical stimulus and the listening environment further, through repeated listening with heightened attention. New input passes "up" the hierarchy continually from the eighth to the second level until the listener is ready to make a preference judgment.

At the very "top" of LeBlanc's hierarchy is the preference judgment, a decision based on the combination of all the variables at the lower levels. The listener *accepts* or *rejects* the musical input. In the event of acceptance, the model assumes repetition until satiation. As stimulus conditions change, or as listener conditions change, the judgment may change.

People will vary in their relative importance of the model's variables and variable categories, but almost all individuals who are able to hear music will share many of the model's aspects. Even people who generally are consid-

ered "different" in some way–be it due to mental retardation, a physical, sensory, or motor impairment, or social deviation–are influenced by many of the variables, and do process the input in some way. While the *amount* of perceived stimulus complexity, authority figure influence, basic attention, or other influence variables may differ drastically (in either direction) from what most other people experience, there will be *some* amount.

Regarding stimulus aspects, recent empirical cross-cultural research supports longstanding beliefs that young people of middle school age will prefer music of faster tempi and will prefer music that "has a beat." (Of course, all music "has a beat," but the youngsters generally mean music with a strong rhythmic emphasis.) LeBlanc et al. (in press) found that listeners aged 10 through 14 generally preferred the fastest of four tempo presentations (mean M. M. = 74, 101, 134, and 210) of traditional jazz examples. This was true for listeners from Brazil (n = 143), China (n = 180), Italy (n = 163), South Africa (n = 257), and the USA (n = 171). (Interestingly, there was a significant country effect, with the Brazilian listeners having the strongest preference for the jazz examples at all tempi, and the American listeners having the lowest preference.) LeBlanc et al. (2002), testing preference for beat strength in instrumental excerpts representing jazz, American popular music, and Western art music, found a preference for examples with a stronger beat among 11- and 12-year-old listeners. There were some variations in their international sample, with interactions between beat strength and country as well as beat strength and gender. Although the overall preference clearly was for stronger beat over weaker beat examples, within listeners from Greece (n = 201), Japan (n = 251), and the USA (n = 190), females rated the weaker beat examples more highly than the males. Except for Greece and Portugal (n = 144), males' preference for stronger beat examples was greater than that of females. The strong beat preference in Japan for both genders was insignificant.

Complexity, another of LeBlanc's input variables, may be an especially important influence on musical preference. As used here, complexity refers to how intricate, ornate, or confusing a stimulus appears; it is a matter of subjective judgment. In appearance, function, and operation, an automobile is more complex than a toy wagon. To Western listeners, a Bach fugue usually appears more complex than a European or American folk song. In information theory terms, a lack of redundancy results in excessive information, which increases complexity. Complexity may be a function of uncertainty, unfamiliarity, and a resulting lack of expectancy. As is the case with other psychological constructs, complexity never can be measured directly, but it can be estimated and quantified by evaluating stimulus properties or people's behaviors.

Investigators may analyze complexity multidimensionally through factor

analysis and/or multidimensional scaling of semantic differential, Likert or similar implied continuum scale, or paired or triadic comparison data. Possible underlying dimensions may relate to melodic direction or ornamentation, harmonic changes and textures, rhythmic regularity, and the degree to which the music meets expectations.[8] A simpler approach to measuring complexity may be based on observers' immediate impressions of apparent complexity. In such a *global* approach, *why* something seems relatively complex or simple is not immediately important; it is enough to say that a stimulus has a certain amount of complexity because of the way people react to it. A global approach recognizes that people may vary considerably in why they make particular complexity judgments. For some listeners, an overall impression of a piece of music may include a degree of apparent complexity which defies analysis. For others, rhythm, harmony, melody, or another musical property may override other properties as a basis for complexity. The authors lean toward a global approach to measuring apparent complexity.

Conceiving musical preference as a function of complexity is not new. Berlyne (1971) and McMullen (1980) alluded to musical affect having a particular relationship to music's structural complexity, a relationship describable as an inverted U-shaped curve; in mathematical terms, a *quadratic* function.[9]

One important development regarding preference as a quadratic function of complexity is Walker's (1980) "hedgehog" theory, so named because the theory has one explanation for many situations, just as the spiny little European animal rolls into a ball in response to many stimuli. Walker (p. 1) states the theory in his own words as "psychological events nearest optimum complexity are preferred. Occurrence produces simplification." The theory presumes an optimal complexity level for any stimulus class, including music. Preference is highest when the stimulus is at the optimal complexity level. Excessive complexity results in less preference, as does excessive simplicity. Too much complexity causes the listener to cease attempting to process the stimulus; too much simplicity causes boredom. As a stimulus recurs, as in repeated listening to a musical composition, it theoretically simplifies. If the stimulus moves closer to the optimum complexity level, preference increases; if it moves further away, preference decreases. If optimal complexity changes, the curve shifts in one direction or the other, and a particular stimulus's relative position on the newly shifted curve may change.

Although optimal complexity levels vary among and within individuals, each individual has an optimal complexity level for a stimulus class at any

[8]For a discussion of factor analysis, multidimensional scaling, and other multivariate techniques in the context of experimental research, see Asmus and Radocy (1992).

[9]In a quadratic function, as variable X increases, variable Y increases–for a while. Then as variable X continues to increase, variable Y decreases. Hence, the descriptive use of "inverted U."

particular time. A group of people can provide an average estimate of the complexity of each object in a stimulus set, such as a collection of musical examples. Heyduk (1975), employing four compositions specifically composed to vary in complexity and a 13-point rating scale, demonstrated the expected complexity-preference relationship as well as reduced complexity with repetition.

Using "real" examples of Western art music rather than contrived examples, Radocy (1982) investigated preference as a function of complexity and familiarity, and complexity as a function of familiarity. As would be expected if a quadratic relationship exists, subjects indeed preferred the examples that they judged as moderately complex. In general, the more familiar the example, the more it was preferred. Although familiarity is supposed to produce simplification, there was no simple relationship between familiarity and judged complexity. A systematic procedure featuring repetition within the confines of a designated time period may be necessary for occurrence to produce simplification. Hargreaves (1984) later found that repetitions over weekly intervals caused changes in preference, presumably due to changes in optimal complexity levels.

Desired or optimal complexity level may interact with the social situation in which the music is heard, as Konecni (1982) demonstrated in a series of studies. Subjects working on a relatively complex task preferred simpler melodies than did subjects working on a simple task. Of more interest, in a series of experiments where the experimenter's accomplice systematically insulted some subjects as they worked on assigned tasks but left other subjects alone, subjects who heard loud complex melodies while considering whether or not to retaliate against the accomplice by administering what they thought were painful electric shocks were more aggressive than subjects who heard simpler melodies or no music. In some cases, even uninsulted subjects appeared stimulated to act aggressively in the presence of loud complex music. Konecni suggests that people aroused by loud complex music may overreact to relatively loud annoyances that they ordinarily would ignore.

Performer identification regarding gender and race may play a role in expressed preferences. Killian (1990) found that junior high students, particularly males, generally preferred performers of the same race and gender as their own. McCrary (1993) found that African-American middle school students gave stronger preferences to the music for which they identified the performer as African-American. White students were nearly equal in their preferences for African-American and white performers.

Altering Preferences

Musical preferences may be altered. One's less preferred style may

become a more preferred style, and a listener may broaden his or her range of choices. Much music requires learning through formal instruction before a listener may experience more than some sort of sound bath. K. Mueller (1970) stressed that listeners can not hear accurately because they are not taught to hear musical details.[10] After studying college and high school students' thematic recognition abilities and finding that typical students showed positive responses toward diverse styles, including classical and jazz, Duerksen (1968) noted the potential for developing and expanding preferences through education. Zenatti (1993) believes that musical taste is partly cognitive, so enhanced cognitive processing ability should facilitate taste for more complex contemporary musical styles. Of course, learning to hear musical details, exposure to musical diversity necessary to expand preferences, and enhancement of musical cognitive processing all require structured instructional time. While examining the literature of educational philosophies and various schemes to hold American education "accountable" is beyond the scope of this text, it is evident that at the beginning of the twenty-first century, music education beyond staged performances may be in jeopardy in many American schools as externally imposed testing procedures that give little or no weight to music and the other arts drive curricula.

Seventh graders who were encouraged to be creative in activities related to contemporary music outscored a control group, who followed an existing curriculum guide, on a test of musical understanding (Archibeque, 1966). Interestingly, all seventh graders in the study developed an interest in contemporary music regardless of prior training, grades, or initial attitudes.

Repetition, a process for making the unfamiliar familiar, may help alter and expand musical preference. Mull (1940) had undergraduate musicians listen to obscure works of Bach, Chopin, and Brahms, and raise their hands to indicate "high spots." With repeated listening, as the music became more familiar, the lengths of the "high spots" increased. Listeners evidently became aroused by anticipation of newly familiar sections and raised their hands in anticipation. Getz (1966) found that seventh graders' preferences for string ensemble excerpts increased over ten weeks as a result of familiarity through repetition. Faster tempos usually elicited greater preference. Schuckert and McDonald (1968) found that four- to six-year-old children altered their musical preferences between jazz and classical music after being required to listen individually to the lesser preferred style during quiet play

[10]To "hear musical details" means to hear various nuances, recall information for recognizing musical form, and relate a myriad of factual information about the music and its performance. A listener's ability to verbalize about the music is evidence of detailed hearing. Hierarchical perceptual structuring, discussed earlier, where "details" of a musical surface structure are subsumed into a deeper structure, may exist without formal musical instruction due to experience in a musical culture.

periods. While research (LeBlanc, 1981; LeBlanc, Colman, McCrary, Sherrill, & Malin, 1988; LeBlanc & Cote, 1983; LeBlanc et al., in press) amply demonstrates that children usually prefer fast to slow music, Moskovitz (1992), assessing fourth graders' selections of fast vs. slow music, found that repetition of slow baroque, classical, romantic, and atonal art music increased preferences for slow excerpts.

Familiarity through repetition will not guarantee an increase in preference, of course. Prior to attending concerts featuring contemporary woodwind quintets, elementary, junior high school, and high school students in a midwestern city heard preview tapes to familiarize them with the music (Hornyak, 1966). Familiarity indeed increased the elementary students' positive response to the contemporary compositions, but it made no difference for junior high pupils. The high school students showed a *less* positive response as a result of preliminary hearing. Cook (1990, p. 174) cautions that instructing people about particular music will not automatically increase enjoyment, and that enjoying music does not require understanding its structural details (pp. 164–165).

In a broad sense, style rather than specific examples may be the basis for familiarity. In a study of the effects of attending an in-school opera performance, Sims (1992) found that attendance had a positive effect on attitudes toward attending opera, opera singing, and the performers, as indicated by significant differences in favor of fifth and sixth graders who attended the opera. Fourth graders were consistently more positive, with little difference between those who saw the opera and those who did not. Opera is a form for which young people generally do not care (LeBlanc, 1981; LeBlanc & Sherrill, 1986; Thompson, 1991).

In a study relating undergraduate nonmusic majors' multicultural attitudes and their preferences for and knowledge of music of Africa, China, India, Indonesia, Japan, Korea, the Middle East, and Thailand, Fung (1994) found a significant relationship between overall scores on a multicultural attitude inventory and overall preference scores. There was no significant relationship between preference and recognition. Significant relationships existed between the students' years of study of foreign language and overall preference, as well as between year in school and overall preference. Apparently, certain social familiarity and attitudes may influence preference when all of the music is relatively unfamiliar.

Musical preferences can be altered, but the direction of alteration is not always predictable. The philosophical question of whether or not preferences *should* be altered is not answered satisfactorily. Music educators and critics should remember that musical preferences result from a complex interaction of personal factors, all of which are not under the control of any one institution. An expansion of preferences may be attempted in educational settings

with reasonable chances of success, but a reordering of musical preferences in some arbitrary direction is questionable. Given the many variables that interact to influence preference, the relative flexibility of younger students, and the importance of musical expectations, one thing that music education can and should do is to provide preschool and elementary school children with a wide variety of experiences in listening to, performing, and creating many musical styles.

Summary

The major points in this chapter include the following:

1. Musical preferences result from a complex mixture of musical, personal, and environmental characteristics.
2. "Good" music may be "good" because of inherent structural aspects; it may be "good" because of what people say about it in context; it may be "good" because of the use to which it is put.
3. Preferences may be related to various personality aspects.
4. Group tendencies exist in musical preference, especially for certain predominantly German composers of Western art music.
5. The apparent reverence for the past observed in classical music is a relatively new occurrence in Western music history; it probably is attributable to perpetuation of tradition through formal education and the widespread availability of music from prior eras as well as radical creations by nonconforming contemporary composers.
6. Popular music exists in many continually evolving forms; each has its own cultural orientation, sociological base, and market.
7. The preferences of many American school children may focus increasingly on rock or country music with advancing grade levels; a person's "open-earedness" may wax and wane with age.
8. Musical preference and taste are a function of many variables, including variables in the music, short-term and long-term variables in the listener, and variables in the conditions under which the music is experienced.
9. LeBlanc's hierarchical model of the sources of variation in musical taste is a comprehensive organization of musical, environmental, and personal variables interacting in preference decisions.
10. Empirical support exists for the particular importance of complexity and tempo as musical variables influencing preference.
11. Musical preferences may be altered and expanded through education, but the results are not always predictable.

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Chapter 10

MUSICAL ABILITY AND LEARNING

Traditional areas of the psychology of music include the measurement and prediction of musical ability and music learning. After devoting separate chapters to each area in the first two editions, the authors merged the areas for the third edition, largely due to emerging understanding of human musical development and changes in concepts of musical ability and theories of learning. For this edition, the authors retain the merged treatment and discuss musical ability, music learning, aspects of musical development, musical abnormalities, and approaches to assessing musical ability. The chapter concludes with a brief set of practical suggestions for facilitating music learning.

Extended Definitions

Ability suggests being "able" to do something. A person with musical ability is able to perform, create, or, perhaps, analyze music if given an opportunity. Unfortunately, people interchange talent, musicality, capacity, and aptitude with ability, and opinions differ regarding the permissible degree of interchange. The definition of learning may be more clear, but one must distinguish learning from other developmental phenomena, and recognize that learning is not an automatic consequence of teaching. The following definitions represent the authors' views, based on their experience and study.

Ability, a broad term defying precise definition, refers to being able to do something, regardless of how a person acquired the necessary knowledge, skills, and experience. People may differ widely in their amounts of musical ability, as well as in the forms in which they manifest their musical abilities. Performing, composing, analyzing, and improvising music are ways to display musical ability. The authors hold that musical aptitude and capacity are within musical ability, and that achievement, while "off to the side," may be evidence of ability.

Aptitude, narrower than ability but broader than capacity, refers to the part of ability resulting from a combination of genetic endowments and environmental experiences with music other than formal music education. Since many music educators' concerns for musical ability relate to predicting a

potential student's musical success prior to providing opportunity for specialized musical learning, musical ability's measurement problems often are problems in measuring musical aptitude.

Capacity, a narrower term yet, refers to a part of a person's ability that he or she possesses as a result of genetic endowment and maturation. To the extent that musical capacity increases, it increases regardless of environmental influences. Superior auditory detection or discrimination ability may be a matter of capacity, although one would need to learn labels for expressing those discriminations.

Achievement refers to specific musical accomplishment, often the result of specific instruction. Reading notation, performing a specific piece, knowing the names of ten major symphony conductors, and recognizing all the themes of Beethoven symphonies and relating them within their formal structures exemplify specific achievements. To assess musical aptitude or capacity via tasks that require specific achievement is inappropriate, but past achievements nevertheless may indicate musical ability, which in turn may suggest possibilities for further achievements.

Other terms related to musical skill or accomplishment include *talent*, an imprecise term designating some obvious indication of ability, usually related to performance, and *musicality*, another imprecise term, referring to being "musical," i.e., being sensitive to existing or potential changes in a musical stimulus. An inexperienced performer may show musicality when he or she tapers a phrase or varies dynamic levels without teacher direction; musicality also simply may mean interest in music.

Development refers to the growth and maturation process through which people go as they move from an embryonic stage, through birth, childhood, and adolescence, to an adult stage. It could include the "disdevelopment" through which many elderly people pass. Development includes the results of physical, emotional, and cognitive maturity; it inevitably interacts with learning. Musically, people pass through stages from the earliest awareness of sounds to, at least occasionally, musical literacy. Many people never "develop" beyond a stage of simple musical recognition and singing.

Learning is an observable change in behavior, due to experience, which is not attributable to anything else. (The authors pattern this after the classic Bower and Hilgard (1981) definition.) According to this definition, without some behavioral change between two points in time, no learning has occurred during that time span. Someone who already can recite major and minor key signatures can not "learn" to do it, although he or she obviously learned the signatures in the past. Furthermore, someone who must ascertain that an individual indeed has learned something requires observable evidence in a behavioral form. Showing a student how to produce a trumpet tone or telling him or her how to recognize ternary form is insufficient; learn-

ing has not occurred until the previously unable student can play a tone or identify an ABA form. While some authorities may recognize so-called "latent" or "hidden" learning, i.e., the student "knows" but somehow can not show what he or she knows, latent learning is nonfunctional or even nonexistent from the standpoint of anyone, such as a music teacher, who requires tangible evidence of learning. If someone "knows," he or she can demonstrate that knowledge.

The qualification in the learning definition of "not attributable to anything else" excludes behavioral changes resulting from maturation or genetic programming. An infant does not "learn" to breathe or to shake violently in the presence of a sudden loud sound; an adolescent boy does not "learn" to grow facial hair. Breathing occurs naturally; the startle response is a reflex action, and the newly hirsute young man is displaying a secondary sexual characteristic.

With the possible exception of "automatic" perceptual subprocesses, such as basilar membrane movement and reflexive startle responses to loud music, the development of any musical behavior requires learning, even when one conceives "musical behavior" very broadly. Genetic and maturational processes or the lack thereof will influence the forms of particular behaviors; consider the qualities of children's, men's, and women's voices, and the seventeenth-century castrati. But people do not organize, analyze, or perform specific musical sounds as a result of instinct or secreted hormones. They *learn* to react to and with music.

Selected Influences on Musical Ability

The development of musical ability depends on what is *in* as well as what is *around* a person. The relative importance of heredity and environment is uncertain, although both conditions obviously are influential. This section discusses various influences.

Auditory Acuity

Music is an aural art form, so, logically, sufficient hearing sensitivity is an essential part of musical ability. Hearing impaired individuals have difficulty experiencing music in a normal manner.[1] Musicians view various hearing ailments with alarm; contemporary performers in rock bands and symphony orchestras may wear specially designed earplugs to preserve their hearing sensitivities. As noted in Chapter 4, instrumental music teachers may be at

[1]The reader should not assume that music is irrelevant for hearing impaired individuals. Varying degrees of impairment exist, and sound may cause tactile as well as auditory stimulation. For a discussion of music's importance in deaf culture, see Darrow (1993).

greater risk for hearing loss than the general population. However, acuity, while a minimal necessity for hearing music, bears little relationship to musical ability beyond the most basic sensory level.

Sherbon (1975) tested hearing threshold, presence of diplacusis,[2] and discrimination skills related to melody, harmony, visual music recognition, musical memory, pitch, loudness, and timbre to undergraduate musicians and nonmusicians. Except for loudness and timbre, musicians outperformed nonmusicians on all discrimination tasks. However, the two groups did not differ in acuity or diplacusis, and neither acuity nor diplacusis showed a significant relationship to any of the seven sets of discrimination test scores. From the standpoint of being "able" to accomplish the required tasks, superior hearing acuity made no difference.

Genetics

Recent developments in understanding the human genome and increased possibilities regarding cloning humans, once dismissed as science fiction, have enhanced interest in genetic endowment. Studies of musical families certainly are not new (Farnsworth, 1969). However, genetic endowment for specific musical accomplishment is unlikely, and even if one could clone a distinguished performer or composer, there is the really important matter of nurture: Bach, Mozart, and many eminent contemporary musicians indeed came from musical families, but studies of their familial situations are as much evidence for the influence of a highly stimulating musical environment as they are for genetic endowment, if not more so.

Certain physical characteristics, which may have some genetic basis, are advantageous for particular performance tasks. Some singers may be gifted with resonant vocal tracts that facilitate singing with a desirable quality. Long finger spans may help pianists perform technically demanding material. Fast reflexes may expedite mastery of woodwind fingerings in complex passages. Hypermobility, a disadvantage in supporting joints such as the knees and spine, is an advantage in joints underlying repetitive finger and wrist functions (Larsson, Baum, Mudholker, & Kollia, 1993).

Belief that musical ability beyond specific performance aspects is largely innate does persist. Bentley (1966), basing his view in part on observing highly diverse levels of musical ability in relatively homogeneous groups of children, maintained that musical abilities are mostly a matter of innate capacity. Scheid and Eccles (1975) suggested that the physical size of the right cerebral hemisphere's planum temporale, located just behind the primary auditory cortex, indicates genetically-coded musical ability. They called for post-

[2]Sherbon tested for *binaural diplacusis*, a condition in which an identical frequency sounds with a different pitch in each ear.

mortem examinations of the brains of high-ability and low-ability musicians. Twenty years later, Schlaug, Jancke, Huang, and Steinmetz (1995), employing positron emission topography, examined the living brains of 30 musicians and compared them with the brains of matched nonmusicians. They found a larger *left* planum temporale in musicians who had absolute pitch; such a difference did not exist between other musicians and nonmusicians. If the planum temporale can grow with environmental stimulation, neither postmortem evidence nor morphometric evidence from living brains is valid as evidence of genetically acquired differences.[3] Aggleton, Kentridge, and Good (1994) found a greater incidence of lefthandedness and mixed dominance for handedness among orchestral performers, composers, and singers of both sexes as compared with the general population, but handedness by itself hardly is a genetic predictor of musical ability.

People do differ in nonenvironmental ways, of course; it is silly to pretend that anyone can accomplish anything, given the right opportunities and education. Someone whose adult height is 150 cm (about 4 ft 11 in) is not likely to play on a professional basketball team; a 250-pound person has little future as a jockey. A child born with Down syndrome is unlikely to become a professional musician, although such a child still may have satisfying experiences with music. Nevertheless, while differences in musical ability due to innate differences in people theoretically may be possible, the evidence for influence of the planum temporale, handedness, or any "natural" physiological or neurological structure remains tenuous.

Musical Home

A musical home nurtures the development of musical ability. Encouragement from parents and siblings and a supportive environment may be critical in stimulating musical interest and maintaining motivation for continual involvement with music. The likely development of absolute pitch through imprinting, discussed in Chapter 4, is one example of nurtured development: The critically-timed label-sensation connections will not occur without teaching and reinforcement. Performance may be more likely later in life when parents and other significant persons encourage young children to perform and reward them for doing so. The all important musical expectancies, previously discussed in the contexts of information theory, hierarchical perceptual structuring, and Meyer's theory of musical enjoyment, arise from experience in a musical culture, and a musical home enhances that cultural experience. A home that encourages active music making may accelerate development in comparison with a home where musical experiences are generally passive, as in listening to recordings.

[3]Indeed, Schlaug et al. caution that they have no evidence regarding just how the observed planum temporale asymmetries came to exist.

Early exposure to and active experience with music certainly are beneficial, but they do not guarantee future musical accomplishment, and, more importantly, a less musical home does not necessarily condemn a child to everlasting musical mediocrity. Recently, Kagan (1998) and Bruer (1999) addressed current tendencies to overemphasize early childhood and ignore the continuing importance of later opportunities. Their concerns provide a healthy balance to concerns for "parental correctness" and excessive amounts of structure and stimulation in nurturing young children.

Kagan (1998, pp. 1–2) includes infant determinism, a belief that a child's experiences during the first two years of life are preserved for a lifetime, as one of three "seductive ideas" that grew from certain interpretations of psychology.[4] Kagan notes (p. 3) that "many early ideas and habits either vanish or undergo such serious transformation that they cannot be retrieved in later life, any more than the first strokes of a seascape can be discerned from the larger scene, once a painting is complete." Later (p. 8), Kagan discusses the importance of discrepancies from past experiences or current expectations as significant causes of thought, feeling, and action. The human tendency to compare one's self with others and the results of those comparisons continually create and reshape beliefs about one's self. Young children generally do not compare their personal qualities systematically until age five or six; this means that events during life's first two years have less significance than some psychologists or members of the popular press have claimed. A child continues to shape and reshape his or her idea of self well into adolescence. In simple language, lots of life remains after early childhood.

Bruer (1999), writing from a perspective of neuroscience, is concerned that people may make educational decisions based on very slight understanding of the human brain when in fact so-called "brain science" is not yet sufficiently linked to human development and education. He finds three "neurological strands" of a "myth" involving life's first three years: Growth and change during the early years, critical periods,[5] and enriched environments. While infant brains have many more synapses than adult brains, the resulting "plasticity" lingers long into adolescence. While learning particular skills may be easier at certain ages, there are large ranges of possibilities for learning. While a lack of stimulation is detrimental to the young child, extra stimulation is not necessarily beneficial. Whether one wishes to nurture musical development or any other human quality, the home environment in early childhood is not the only factor. Bruer (pp. 209–210) has some advice, born of skepticism as well as what he sees as excessive attention to incomplete

[4]The other two "seductive ideas" are the belief that most psychological processes generalize broadly across contexts and species, and that most human action is motivated by pleasure.

[5]Yes, Chapter 4 presented evidence for a "critical period" of absolute pitch development!

knowledge:

> Brain science and the Myth [of life's first three years] have nothing new to say. Parents can talk, sing, and read to their babies. It can't and doesn't hurt. Brain science, even if we add in behavioral science, cannot tell us how to raise a scientifically correct child. Parents should realize that children thrive in a wide variety of physical and cultural environments and learn and benefit from experiences throughout their lives. Being highly critical and skeptical of any claims to the contrary is one of the best things parents could do for their children.

So, the musical home is important, but it is not the only aspect of musical ability, and "home" continues well beyond early childhood.

Physical Features

Physical features such as teeth alignment, joint flexibility, and lip, hand, and finger sizes (which reflect genetic influences) may influence performing ability regarding particular instruments. The upper lip protrusion known as a Cupid's bow makes it difficult to form a characteristic flute embouchure. Children with tiny fingers have difficulty covering clarinet fingerholes, and a pronounced overbite makes forming a trumpet embouchure difficult. Dental trauma, vocal nodules, and physical debilitation resulting from muscular overuse or misuse may cause serious difficulties for experienced performers. Hypermobility, noted above, may be advantageous for instrumentalists who must routinely perform technically intricate passages. Ability in a specific performance medium is only a part of musical ability, however. If physical influences on overall musical ability are important, they should relate to many aspects of musical ability.

Creativity

Composition and improvisation obviously require creativity; the composer or performer creates a new sequence of sounds and silences. Performances of notated music may be creative (although imitative stereotypical performances may be more *re*creative), and a person can listen in creative ways. Since music is at least partly a creative art form, attempts to relate musical ability to some general creative ability are logical, but explaining musical ability as a function of creativity is largely unsuccessful, partly because of difficulties in defining creativity adequately.

Creativity may require production or simply may be a process. Guilford (1957) stressed that creative ability is multifaceted, with fluency, flexibility, originality, and evaluative factors of particular importance for a creative artist. Radocy (1971) suggested that creativity may be in the eyes and ears of

the beholder: If an observer judges some product or act as creative, rather than ordinary, unmusical, "wrong," or bizarre, it *is* creative, at least for the observer. In their study comparing highly creative with highly intelligent high school students, Getzels and Jackson (1962) adopted criteria for creativity that stressed novel and even peculiar descriptions and narratives. In one example, a "creative" student submitted a blank sheet of paper, allegedly depicting children playing in a schoolyard, and indicated that the children were playing during a snowstorm. Such a student may be creative, or, perhaps, the student was sarcastic or simply interested in avoiding work.[6] Conceivably, anyone with a sense of humor and ability to spot absurdities in daily life could be highly creative if creativity is synonymous with inventiveness.

Creativity in the sense of inventiveness may be highly useful in composition, improvisation, and arranging. Yet, inventiveness, as well as divergent thinking and bizarre behavior, may hinder progress in musical development and learning; defying cultural musical expectations may be considered ignorance rather than creativity.[7] Creativity may characterize the musically able, but without discipline and direction, creativity is insufficient to make a person musically successful.

Intelligence

Intelligence logically is an important influence on musical ability. A relatively intelligent person ought to be able to cope with musical problems with more success than a relatively unintelligent person, if one defines intelligence as coping with intellectual demands of the environment. As with creativity, definition problems have clouded the relationship of intelligence and musical ability. Kagan (1998, p. 1) cautions against generalizing psychological processes, including intelligence, across differing contexts. Different measurement tools and different conceptions of intelligence imply different definitions. We will consider some traditional relationships, the phenomenon of the idiot savant, and "musical" intelligence as a part of multiple intelligences.

Intelligence in the traditional sense of academic abilities may not be essen-

[6]There is no shortage of anecdotes involving clever "creative" responses to assignments. Mehrens and Lehmann (1973) describe the student who, in response to a physics test question regarding measuring the height of a tall building by using a barometer, posed several creative answers, including offering to give the building superintendent the barometer if the superintendent would tell him how tall the building was. More brazen, perhaps, was the student who when asked to write a 500-word English theme about an object in his room wrote, "In my room is a clock. The clock goes tick-tock, tick-tock, ..." Are these students creative?

[7]Of course, *who* does something "creative" may be more important than *what* is done. A novel interpretation of a well-known musical score may be hailed as a stroke of creative genius if done by an eminent conductor, but labelled as an ignorant misunderstanding of musical literature if done by an amateur conductor.

tial for musical ability. Gordon (1968) reported that musical aptitude scores often related only slightly to intelligence, although, in European studies, performance ratings related more highly to intelligence. He found (not surprisingly) that his own musical aptitude measures were better predictors of musical success, as measured by etude performance, teacher ratings, and a notation test after three years of instruction, than were intelligence scores. Yet, the logic that intelligence *ought* to relate to musical success persists.

Sergeant and Thatcher (1974) suggested that correlational studies, comparing scores on intelligence tests with musical ability measures, could indicate spuriously low relationships due to problems with test reliability and validity. Using analysis of variance and trend analysis techniques on a variety of data, they concluded that the intelligence-musical ability relationship is asymmetric: All highly musical people appear to be highly intelligent, but not all highly intelligent people appear to be highly musical. Of course, musical ability requires an interaction between intelligence and appropriate environmental stimulation. Phillips (1976) suggested a close relationship between musical ability and intelligence, believed to result from a common environmental cause: A home promoting musical ability also is likely to promote intelligence.

Idiots savant constitute a continuing dilemma for advocates of a close relationship between intelligence, conceived as a general form of intellectual ability, and musical ability. An idiot savant[8] is a person of subnormal intelligence who displays remarkable ability in one or more narrow areas. Anastasi and Levee (1960) described a 38-year-old man with exceptional keyboard ability. The man appeared to concentrate only when he played the piano, often for six to nine hours daily. An excellent sightreader who also could play by ear, he preferred music from the classic period. He also had a phenomenal verbatim memory for printed passages and events which occurred one month or more in the past. Brain damaged due to encephalitis, the man did not walk until 18 months and did not talk until age five. He hummed tunes before he talked, and a speech therapist taught him to speak by using song lyrics.

Sloboda, Hermelin, and O'Connor (1985) described NP, an idiot savant residing in a residential home for autistic persons.[9] Although NP displayed

[8]A "savant" is a scholar, so an idiot savant is an "idiotic scholar." While today, "idiot" is a pejorative term connoting personal stupidity or irresponsibility, the term once had a relatively precise technical meaning. A "moron" was a person in the highest functioning group of individuals having subnormal intelligence, an "imbecile" was in the middle group, and an "idiot" was in the lowest group.

[9]Autistic individuals manifest severely impaired social interactions and communication and display stereotypical patterns of repetitive behaviors and interests (American Psychiatric Association, 1994, pp. 66–67). Autism is a relatively specific condition; the term should not be used as a synonym for mental retardation, behavioral disorders, or nonadaptive behaviors.

bizarre behaviors, rarely produced spontaneous speech, avoided looking at people, and had minimal verbal intelligence, he was delighted to play the piano, and he had a phenomenal ability to memorize music. In a comparison with the memorization skills of a professional pianist, NP easily "outmemorized" the professional in the task of memorizing a piece by Grieg, but he did not do well at all in memorizing an atonal piece by Bartok. The investigators reported error rates of 8 percent for NP and 63 percent for the professional on the Grieg; for the Bartok, the corresponding rates were 80 and 14 percent. Of considerable interest to students of cognitive musical processing, NP's ability apparently is based in structures and relations of tonal music. Readers may find further documentation of profound musical abilities accompanying profound intellectual deficits in Miller (1989).

Idiots savant are less of a problem when one conceives intelligence as a set of loosely related skills or as a collection of multiple intelligences. Historically, psychologists have conceived of intelligence as a set of loosely related skills (Thurstone, 1947) or as a set of closely related skills, dominated by one general factor (Spearman, 1927). Parallel beliefs regarding musical ability include Seashore's (1938) "theory of specifics" and Mursell's (1937) "omnibus theory." Occasionally, people group the two respective schools of thought as "foxes" (a fox has many ways to avoid predators) and "hedgehogs" (a hedgehog has basically one response–rolling into a ball–to many situations) (Gardner, 1993; Walker, 1980).

Gardner (1993, 1999) developed and refined a theory of multiple intelligences which is attractive to music educators and other individuals concerned with music's role in the human experience because it includes a *musical* intelligence. Gardner's first set of intelligences (1993) also included linguistic, logical-mathematical, spatial, bodily-kinesthetic, interpersonal, and intrapersonal intelligences. Later (1999, pp. 48–60), he added a "naturalist" intelligence and, while not adding it to the list, discussed a possible spiritual or existential intelligence.

Gardner's definition of and criteria for an intelligence are of particular interest. In 1999, he revised his earlier definition regarding problem solution and product creation in culturally valued ways to stress biological and neurological potentials:

> I now conceptualize an intelligence as a *biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture.* This . . . suggests that intelligences are not things that can be seen or counted. Instead, they are potentials–presumably, neural ones–that will or will not be activated, depending on the values of a particular culture, the opportunities available in that culture, and the personal decisions made by individuals and/or their families, schoolteachers, and others. (pp. 33–34)

While musical ability is a broad term, encompassing accomplishments as well as potentials, Gardner clearly is stressing potentials; any intelligence-musical ability relationship may be one of potentials. His criteria for an intelligence, in the 1999 (pp. 36–41) revised version, include (a) potential isolation by brain damage, (b) a basis in human evolution, (c) a core set of operations, (d) phenomena which one may encode in a symbol system, (e) a clear pattern of human development that leads to expertise, (f) exceptional individuals such as idiots savant and prodigies, (g) evidence arising from experimental psychology, and (h) psychometric evidence. Certainly, (a) brain trauma can severely impair musical skill, as noted earlier; (b) music may have an evolutionary basis; (c) music involves distinct operations on sequences of sounds and silences; (d) music notation systems are well-established; (e) as discussed below, investigators have identified clear sequences of musical development; (f) musical idiots savant and prodigies exist; (g) experiments of many sorts address and manipulate musical processes; and (h) musical skills are measured in various ways. Indeed, the evidence for a musical intelligence is strong.

Measurement of musical intelligence, or of any of the other intelligences in Gardner's intellectual pantheon, is less developed than conceptualization. Measurement through any one-time testing session, as in studies comparing musical ability or aptitude scores with verbal intelligence scores, is inadequate. Measuring the discrepancy between what a person can do initially and what that person can do after a month of instruction, in accordance with Vygotsky's (1978) *zone of proximal development,* may offer some possibilities.

In any case, the various intelligences rarely if ever exist in equal amounts. Furthermore, the degree of separation of the intelligences may not be as succinct as Gardner suggests: Shaw (2000) insists that music and mathematics requiring spatial-temporal reasoning are connected because the requisite cognitive processing employs identical cortical areas, and people have an innate ability to recognize symmetries and employ them in pattern perception and organization. In any case, multiple intelligences conceptually offer opportunity to assess a person's capabilities as stages in the developmental sequences of diverse human potentials. Musical ability may be a function of musical intelligence and the opportunity to develop that intelligence.

Gender and Race

Gender presents an apparent paradox regarding musical ability. Girls dominate in many school musical organizations, which can be verified by examining membership lists and attending concerts and music festivals. In a nationwide examination of performers' gender as indicated by schools' and colleges' concert programs from over a 30-year period, Zervoudakes and

Tanur (1994) found that the proportion of female players among those playing historically "male" instruments (bassoon, saxophone, French horn, trumpet, trombone, euphonium, tuba, contrabass, percussion) increased, but so did the proportion of females among those playing historically "female" instruments (flute, oboe, clarinet, violin, viola).[10] Zervoudakes and Tanur concluded that gender-based segregation for instrument types increased at the high school and college levels, although not at the elementary school level. Yet, except for certain types of vocalists, many, if not most, professional performers are males. Much of this results from sexual stereotyping and discrimination, not any inherent gender-based differences in musical ability. O'Neill (1997) noted that despite a lack of evidence of gender differences in musical ability, men continue to dominate as professional musicians: Gender-based stereotypes of "proper" musical roles change very slowly, more so than in some other areas of society.

Stereotypes indeed persist. In the nineteenth century, many middle class American females were encouraged to become musically proficient but not *too* proficient if they wanted to retain their social stature; males who studied music risked being labelled as effeminate (Koza, 1990). During the late nineteenth and early twentieth centuries, when vast numbers of people from eastern and southern Europe came to the United States and established numerous ethnic subcultures, many immigrant parents expected their children to study an instrument–often stereotyped as violin for the boys, piano for the girls (Rubin, 1973; Tawa, 1982). Over three score years ago, Gilbert (1942) found a self-perpetuating stereotype of women being more "artistic," resulting from musical training being given more readily to girls. Later, in a study of illustrations used in music-related middle school textbooks, Koza (1994) found that females were underrepresented in illustrations, despite their high degree of involvement in school music, and illustrations tended to reflect gender-based stereotypes, such as depicting females as amateurs, rather than as professionals.

Realistically, with the exception of differences due to vocal ranges, apparent gender-based differences in musical ability and achievement are a cultural artifact. Bentley (1966), studying data obtained from the construction of musical aptitude measures, found no inherent male-female differences in musical ability. Certainly, women in prior years were encouraged to excel only to a certain degree, and stigmas regarding who should play particular instruments existed (Figgs, 1976), but individual differences in musical ability are based in *human* differences. Conception with an XX rather than an XY

[10]Zervoudakes and Tanur based their instrumental gender classifications on previous research regarding stereotyping of instruments (Abeles & Porter, 1978; Delzell & Leppla, 1992). One could argue about any particular classification, especially if one has experienced proficient performers of the opposite gender.

chromosome match (or vice versa) does not limit the potential for musical achievement. Nurture in accordance with stereotypical cultural expectations might be limiting.

Just as social conditions and beliefs may perpetuate gender-based stereotypes and encourage or discourage musical involvement, so may racial and ethnic-based expectancies encourage or discourage musical involvement. Such differences are cultural, not the result of any inherent differences due to being born into any particular ethnic group. African-Americans do not necessarily "have rhythm," nor are they necessarily rap artists. Not all Italians are singers. Not all Hungarians are violinists. While one may argue legitimately that "understanding" a musical culture requires longstanding experiences in that culture, such "understanding" results from cultural immersion, not inherent ethnicity.

Summary of Influences on Musical Ability

We have addressed several possible influences on musical ability, and found varying degrees of fault with all of them. As long as minimal physical and perceptual capacities are present, genetics, hearing acuity, and physical features are of little importance. Gender and ethnicity are irrelevant psychologically, although certainly not sociologically. Creativity is too ill-defined to be very helpful in predicting musical ability and its likely growth. Idiots savant to the contrary, it is difficult to be highly musically able without being reasonably intelligent, although intelligence likely exists in different forms and manifestations, with varying relationships and interactions among them. The constituents of musical ability vary with how they are conceptualized, defined, and measured. So what *does* influence musical ability? The major determinants of musical ability are not yet understood. However, musical ability probably results from a complex interaction of *audition, physical coordination, intelligence,* and *experience.* Attempts to measure and predict musical ability have yielded interesting descriptive information, and a sequence of musical development is apparent.

Normal Musical Development and Learning

Development, defined above as "the growth and maturation process through which people go as they move from an embryonic stage, through birth, childhood, and adolescence, to an adult stage," and learning, defined as "an observable change in behavior, due to experience, which is not attributable to anything else," are intertwined. Development may connote more of a natural "unfolding" of abilities with advancing age while learning may connote the result of deliberate effort, but they are related intimately. We shall review some basic learning theories and then present a developmental

sequence. The reader should remember that learning occurs during development, and learning fosters development.

Theoretical Bases

One traditional classification of learning theories is the two-fold categorization into *behavioral-associationist* (or stimulus-response, or trial-and-error) theories and the *cognitive-organizational* (or cognitive-field, or insightful) theories. Distinctions are not always clear, but, essentially, behavioral-associationists prefer an empirical approach to studying learning and view it in terms of behavioral sequences, habit acquisition, and trial-and-error. Cognitive-organizational theorists, often employing a more rational approach, are more concerned with central brain processes, structuring and restructuring of cognitive fields, and insightful problem solving (Bower & Hilgard, 1981, pp. 2–8). Notterman and Drewry (1993) identify seven schools of thought or "paradigms" of learning: functionalism, associationism, "dialectical-materialist" psychology, behaviorism, Gestalt psychology, Freudian psychoanalysis, and cognitive psychology. (One may group the first four schools into the behavioral-associationist camp and the remaining three into the cognitive-organizational.)

While one can assume a "good guys vs. bad guys" posture regarding theoretical positions and laud one school or theory while excoriating others, no one theory accounts adequately for all learning phenomena. No theory which survives in the literature completely lacks utility. As Lathrop (1970) noted at a time when music educators were "discovering" learning theory, learning theory does not offer instant explanations of or solutions to music learning problems.[11] Despite the lack of any "winning" theoretical position, theoretical frameworks are useful in planning instruction and therapy, developing curricula, and questioning reasons for particular professional practices. The theories discussed below represent the two major schools.

BEHAVIORAL-ASSOCIATIONIST THEORIES. E. L. Thorndike (1932) viewed learning as resulting from the connection of stimuli with responses through loosely conceived "bonds." Proper use of reward and reinforcement would help establish the bonds. A "satisfying state of affairs" would strengthen connections; established connections could be strengthened through reward for practice. The bonds lacked any physical reality, and few today seriously consider Thorndike's views as a basis on which to build learning experiences; *however,* his positions regarding the importance of reinforcement and the

[11]Music educators (or organizations thereof) historically have tended to "discover" various theories or techniques, and endorse and attempt to apply them with little understanding of what they have discovered. The "Mozart effect," discussed in Chapter 3, is a recent example. (The authors are music educators, with over 80 years of collective experience in the field.)

need to encourage through the use of reward maintain contemporary importance.

I. P. Pavlov (1927), a Russian physiologist who won a Nobel prize in 1904, established the classical conditioning paradigm (ding-slurp), refined to a high degree in his well-known experiments with dogs. The paradigm, also known as Pavlovian conditioning, operates, schematically, as

(1)		US-UR
(2)	(CS)	US-UR
(3)		CS-CR,

where (1) an unconditioned stimulus naturally elicits an unconditioned response, as when a hungry dog salivates in response to meat powder, a person leaps because of a sudden loud noise, or a person blinks an eye because a puff of air strikes it; (2) the conditioned stimulus–a ringing bell, verbal command, or some other signal–precedes the unconditioned stimulus; and (3) eventually the conditioned stimulus elicits the same response, now a conditioned response. With judicious reinforcement by occasional presentation of the unconditioned stimulus, the precision of the conditioned response may be increased.[12] Failure to present the unconditioned stimulus eventually will break the CS-CR linkage; the response is "extinguished." Conditioning is not limited to "lower" animals; among humans, student fear of particular teachers, reactions to particular functional household objects at certain times of day, and special behaviors of trained troops and marching bands exemplify conditioning. It is very difficult to apply Pavlov's system except in narrow applications because the requisite US-UR links are seldom apparent, and extinction of undesirable generalizations to similar stimuli by withholding the unconditioned stimulus is not always practical; yet, classical conditioning explains some routine "automatic" behaviors in varied settings.

E. R. Guthrie (1952) stressed contiguity, as did Pavlov, but found the classical conditioning paradigm too restrictive. Rather than viewing learning as the substitution of one stimulus for another, Guthrie conceptualized the stimulus as being conditioned to the response. Guthrie believed that a person would connect a movement (overt or covert) that *changed* a stimulus ("shut it off") *to* that stimulus. Future occurrences of a stimulus would be met with the movement; if the stimulus changed, a different movement would be necessary. Learning supposedly occurs in one trial, at full strength. Guthrie's theory handles the obvious criticism that complex tasks, such as playing a piece on the piano, are not learned in one trial by conceiving a complex task as a myriad of simpler tasks, each of which is learned in one trial. In Guthrie's system, reinforcement is important because it "protects" behavior from new associations; strengthening responses is nonexistent. One practices not to strengthen existing skills, but rather to change or protect those skills. Learning is habit formation, and once a person learns a habit, he or she never can "unlearn" or "break" the habit–he or she can only replace it. A student who finally stops habitually playing a notated F# as F in a particular piece has replaced the incorrect habit with the correct one. Guthrie's theory is flexible, albeit somewhat lacking in precision; its utility probably lies in its constructs of habit replacement and the all-or-none occurrence of parts of a complex task at definite points in time. The wisdom of practicing for a performance in conditions simulating the expected performance conditions as closely as possible also flows from Guthrie's theory.

[12]Among other stimuli, Pavlov employed tones. By selective presentation of an unconditioned stimulus, he was able to make some dogs salivate to A = 440 Hz but not generalize to 441 Hz!

A strict behavioral conception of learning may have reached its zenith in B. F. Skinner's (1938, 1953) views, where *operant conditioning*, in which an emitted response is strengthened and made more likely through selective reinforcement, is the basis for learning.[13] If an encaged pigeon pecks at a particular spot and receives food as a consequence, the pigeon is more likely to peck at that spot again and can learn to do it when requiring food. If a cat escapes from a cage by a certain combination of movements, that combination is more likely to occur when the cat is recaged; the cat can "learn" to escape. If a baby "discovers" that dropping a toy from the crib brings Mother's solicitous attention, the baby is more likely to drop the toy again; the baby learns to fetch Mother. A series of selective reinforcements can build rather intricate chains of behavior. Reinforcement may occur continuously, in which case the experimenter, "behavior manager," or teacher rewards each and every desired response, or intermittently, where only selected desired responses are rewarded. Many arrangements are possible; Bower and Hilgard (1981, p. 180) indicate that responses developed under variable time interval reinforcement schedules are unusually resistant to extinction.

In theory, the proper reinforcement schedule added to opportunities arranged in the proper sequence virtually guarantees the stimulus discrimination and response differentiation necessary for performing clearly structured tasks. Skinner's work is a basis for linear programmed instruction, in which learning proceeds, relatively error-free, in small sequential steps according to a structured presentation of the material. While Skinner was rather unsuccessful in accounting for development of verbal behavior, study of reinforcement schedules may be quite beneficial in encouraging develop-

[13]In operant, "Skinnerian," or "instrumental" conditioning, the organism *emits* a response as part of naturally occurring behavior. In classical, "Pavlovian," or "S-R" conditioning, the stimulus *elicits* or "pulls out" the response.

ment of precisely defined skills. As most experienced music teachers recognize, constant praise becomes ineffective; a variable praise schedule will, in the long run, motivate more students to higher goals. Secondary reinforcers, such as praise, do work with many human learners, and a careful structuring of reinforcement is a powerful learning aid. Greer (1981) presents a useful review of manipulations of reinforcement contingencies in studies pertaining to music education. Skinner's 1938 and 1953 texts present his system in detail; his *Beyond Freedom and Dignity* (1971) presents his case that people are not "free" because they always are subject to environmental controls. Skinner believed that systematic planned positive controls would be superior to existing quasi-random controls.

Except for "true believers," behavioral-associationist theories fell into some disfavor during the last quarter of the twentieth century among people interested in music learning. Cognitive-organizational theories seemed more appealing because such theories more easily accommodated emerging interests in cognitive and neural frameworks, and the older work of the Gestalt psychologists regained some favor. Yet, the classic behavior-associationist theories maintain some contemporary utility (humans *are* conditioned to various stimuli, rewards *indeed may* increase occurrence of desired (or undesired) behavior), and, as we will examine briefly after addressing cognitive-organizational theories, behavioristic views may enjoy a renaissance.

COGNITIVE-ORGANIZATIONAL THEORIES. Many developments in viewing learning as the organization and reorganization of cognitive structures flow from the work of the Gestalt psychologists, of whom Köhler, Wertheimer, and Koffka were leaders. While they were primarily interested in perception, perception extends to learning; in the Gestalt view, learning is a matter of perceptual organization. While not new, Gestalt theories have contemporary importance in theories about aspects of music perception. Some melodies are inherently easier to organize and learn than others due to structural aspects. Auditory stream segregation and the tonal hierarchy, mentioned earlier in this text, relate to Gestalt considerations.

One should not simply equate "Gestalt" with "nonbehaviorism" or assume that all cognitive theories are Gestalt. Gestalt theory is a specific set of organizational principles in the service of "good figures." The term Gestalt may mean shape or form as a stimulus attribute, or it may mean an entity in itself. For the advocate of a Gestalt view of learning, problem solving is structuring and restructuring perceptual relations to make "good figures" or "good Gestalts." "Good" constructions may occur in any sensory mode; while Gestalt principles often are illustrated visually, auditory perception follows the same principles. Gestalt theorists make much of insightful behavior, which advocates of behavioral-associationist theories are far less likely to consider. Insight requires grasping proper relations in perceptual fields.

In Gestalt theory, learning requires coherence rather than association. The theory's essence is the *Law of Prägnanz* (compactness), which states that psychological organization is toward "good" or "harmonious" figures. Four sublaws of the *Law of Prägnanz* help clarify just what a "good" or "harmonious" figure is.[14]

The *Law of Proximity* states that one groups elements to make a figure in accordance with the elements' nearness or proximity to each other. A person is more likely to group the pattern 11 11 11 11 as four twos than as two fours or one two and two threes. With sequential tones, people are more likely to group sounds that are closer in pitch as a melodic idiom or figure; Lundin's (1967) melodic principle of propinquity (see Chapter 6) is grounded in the Law of Proximity. The tonal hierarchy (Krumhansl, 1979, 1990) of close and distant tones within an established tonal context grows from a perceptual proximity of tones related to a tonal center through a triadic relationship. Von Hippel (2000) wishes to qualify proximity in pitch relations to account for the influence on melodic structure of the range of pitch distributions (tessitura) and tendencies for larger tonal distances to occur at extremes of the melodic range (mobility).

If not overridden by proximity, objects with similar attributes, such as shape, color, or timbre, will group together in accordance with the *Law of Similarity*. A listener often will hear a musical idiom containing groups of four sixteenth notes (semiquavers), as in

as a duet when played by one instrument with contrasting timbres such as a clarinet: The last three tones of each group are in a different register than the first and are within a semitone; they are "similar." (From a frequency standpoint they also are "proximate.")

The *Law of Simplicity* relates to a perceptual preference for smoothness, regularity, and symmetry as compared with roughness, irregularity, and asymmetry; it relates to making perceptual order out of chaos.

The *Law of Common Direction* refers to grouping on the basis of extrapolated completion. The incomplete lower case cursive letter *d* easily can look like *cl*, but a reader can see it as a *d* from the context of the word. Incomplete notes and clefs abound in hand-notated music manuscript, but experienced

[14]The authors elect to use the traditional term "law" or "sublaw," even though in modern use most "laws" are more appropriately termed "hypotheses" or "principles."

performers generally have no difficulty interpreting them.

In commenting on the basic Gestalt sublaws, which he prefers to call principles, Shepard (1999, p. 33) suggests that the Laws of Proximity, Similarity, Simplicity, and Common Direction are weak grouping principles, employed when information is ambiguous or limited to sensory input. He feels that a principle of *common fate,* where objects moving simultaneously become connected, is much stronger. Perhaps melodic and harmonic movement toward cadence points exemplifies common fate. Nevertheless, the putative "weak" principles can be rather strong aids to perceptual organization.

Careful perceptual organization can facilitate music learning. For example, music manuscript that violates the principle of rhythmic spacing[15] is asking for music reading difficulties, especially with inexperienced performers, because of the Law of Proximity. The Law of Simplicity suggests that a teacher should begin "music appreciation" with novice listeners by using music with predictable and readily perceivable forms. Köhler's (1929) text is a good source for exploring classic Gestalt viewpoints.

Piaget, a Swiss biologist, founded a theory of *genetic epistemology,* a melange of formal logic and psychology. Developed from observations of children in natural settings, the theory hypothesizes four major developmental stages through which all children must pass in order to become mentally mature adults.

In the initial *sensorimotor* stage, lasting from birth until about two years of age, the child essentially moves from a type of motor intelligence to a more symbolic intelligence as voluntary movements replace reflexive behavior. During the sensorimotor stage, the child acquires object permanence, i.e., moves from a literal state of "out-of-sight, out-of-mind" to recognition that a toy or other object exists even when it is not in the child's immediate environment.

In the *preoperational* stage, lasting roughly from ages two through seven, the child moves through various illogical and incomplete concepts. Perception dominates reason, as in a child saying that a higher or wider container holds more beads than a lower or narrower container, despite seeing equal amounts of beads placed in each container. LeFrancois (1982, pp. 228–229) indicates that a peculiar transductive reasoning, in which the child goes from specific instance to specific instance, as in assuming that any two animals that give milk belong to the same species, characterizes the preoperational stage.

From roughly age seven through 11 or a little older, the child is in the stage

[15]The principle of rhythmic spacing is a notational convention that requires the empty spaces following notes to be proportional to note values; e.g., more space should follow a quarter note (crotchet) than an eighth note (quaver). Similarly, the amount of space occupied by two successive eighth notes should be about what a single quarter note would occupy.

of *concrete operations,* a time during which thought processes depend on a concrete framework. One aspect of the stage is the child's effort to learn conservation, i.e., the recognition that changes can occur in an object's form or spatial arrangement without changing the object's other attributes. In volume relations, a conserving child recognizes that two initially identical amounts of water remain identical when they are poured into containers of different shapes, but a nonconserving child may insist that suddenly there is more water in a wide shallow pan than in a tall test tube, or vice versa. When the water is poured back into the original identical containers, the same child will quite easily say that the amounts of water are identical.

Pflederer (1967) identified five types of music conservation: (a) *identity,* where thematic material maintains its essential characteristics across various permutations; (b) *metrical groupings,* in which the listener recognizes and discriminates among meters despite changes in note value distributions within measures; (c) *augmentation and diminution,* recognition that respective lengthening and shortening of a melodic passage's note values does not change the basic tonal relations; (d) *transposition,* where a change in frequency level does not alter perception of tonal configurations; and (e) *inversion,* where the listener recognizes an inverted simultaneous or successive interval. Conservation is of interest to some music researchers and teachers, partly because children in the concrete operations stage often are beginning formal musical training and conservation is necessary for form perception and musical analysis. Conservation's arrival time will vary greatly with individuals, and all aspects of a developmental stage must occur; attempts to accelerate conservation are highly questionable.

Piaget's final major stage is *formal operations,* where the child is capable of formal propositional thinking and can combine various grouping operations. The adolescent now can consider diverse possibilities, make "what if" judgments, and organize principles into networks. While the child/adolescent may not be "wise," he or she now is a mental adult.

Equilibration is the self-regulated process which is the basis for psychological development and learning in Piaget's system. It includes *assimilation,* in which a learner accepts a new environmental experience into the existing cognitive structure, and *accommodation,* in which a learner alters the cognitive structure to take cognizance of a new reality. Learning problems may result when the learner ignores details in a "new" stimulus and assimilates rather than accommodates.

Near the end of the twentieth century, Piaget's system came under increasing criticism, partly because of the difficulty of applying his theory in detail. In a rather negative review, Serafine (1980) notes that Piaget sought to study how the "mind" becomes capable of thought, language, and knowledge, and was rather unconcerned with learning and individual differences. She also

believes that musical conservation tasks may lack validity because of possible confusion of aural perception difficulties with lack of conservation. Gardner (1993, pp. 20–22), while crediting Piaget with developing important broad guidelines for child development, believes that research shows that Piaget's stages are far more continuous and gradual in their transitions than Piaget indicated. Furthermore, Piaget's operations are more content specific than they might theoretically appear; for example, a child might exhibit conservation with some materials but not with others. Piaget's theory probably is most applicable to the development of "scientific" thinking in Western literate societies; it may be less applicable to the arts and other cultures.

Despite the real danger of overcategorizing children in stages on the basis of ungeneralizable evidence and unwarranted concern with conservation, Piaget's work remains valuable because it clearly shows that children are not miniature adults. Music teachers must present material to children in ways in which the children are ready to assimilate or accommodate it. Excessively philosophical questions (what if . . .) without concrete referents are unsuited to a child in the stage of concrete operations. The relevant Hilgard and Bower (1975) chapter provides a comprehensive overview of Piaget's system. Piaget's *The Psychology of Intelligence* (1950) and *The Psychology of the Child* (1969), coauthored by Piaget and Inhelder, discuss his work and views in detail.

Vygotsky, an increasingly cited theorist, was especially interested in children's development of "inner speech" and thought, as well as how formal instruction might expand operations. Vygotsky believed that higher cognitive processes differ qualitatively from fundamental sensory processes. Social interaction is critical for intellectual development. A *zone of proximal development* (ZPD) represents the difference between a person's current ability or achievement and what that person might be able to do if given instruction and opportunity. In the sense of intelligence testing, musical or otherwise, a greater ZPD might indicate higher intelligence; conversely, more efficient or appropriate instruction might widen the ZPD. Day (1983) and translations of Vygotsky's (1962, 1978) works provide insights into Vygotsky's theory and philosophy and the functional importance of the ZPD.

Cognitive-organizational theories may view people as information processors; i.e., people continually receive information and ignore it or use it in accordance with their needs and desires. Young, Barab, and Garrett (2000) suggest that learning occurs through a *perceiving-acting cycle,* in which people detect information on the basis of their intentions and various environmental constraints. Detection is followed by action, in which people change their environments in order to alter and employ *effectivity-affordance relationships.* According to Young et al. (2000, p. 150), "affordances are the properties of an environment, specified by the information field, that enable action. Effectivities are the abilities of an individual to take action." In somewhat simpler terms, individuals are sensitive to opportunities in their surroundings; if it is beneficial to take advantage of opportunities, they will do so to the best of their abilities. Learning may be a matter of recognizing one's opportunities and skills. Helping one become sensitive to facilitating information may be the heart of instruction.

SO WHO'S "RIGHT"? Are the behavioral-associationist or the cognitive-organizational theorists right? Is learning a matter of trial-and-error, facilitated by judicious behavior management? Is learning a matter of mental organization, facilitated by environmental arrangements? While "true believers" in one theory or another may mount the academic ramparts in support of their positions, realistically, there is no clear winner between the schools of thought or among the particular theories therein. Various problems in human learning may be addressed through alternative approaches: For example, someone who has difficulty in matching pitches vocally may learn to match through a carefully structured program that rewards more and more precise approximations of correct pitch, or they may gain an "understanding" of pitch relationships and vocal production through a thought process.

In recent years, cognitive-organizational theories probably have been more dominant. They allow for underlying mental processes, and study of the "mind" as a separate entity from the brain is permissible. The mind is what the brain does. The brain is an anatomical structure. One can hold a brain in the hands; one can not hold a mind. As Restak (1984, p. 281) suggests, the mind is a collection of thought processes and mental products, a metaphysical system that is *of* the brain but not *in* the brain. In cognitive-organizational theorizing, one can propose various abstract mental structures without anatomical details and metaphysically, mental structures may exist "beyond" any anatomy.

The great pendulum swings; the *zeitgeist* changes. Staddon (2001) presents a "new" behaviorism. After reviewing and critiqueing behaviorism, he concludes that earlier behaviorists promised more than they could deliver and that an S-R view of learning is too limiting. Then he proceeds to offer a "new" behaviorism which purports to move psychology away from excessive concerns with "mental life" and back to a concern for a scientific core, the "economical description of nature" (p. xii). In Staddon's opinion, cognitive approaches were welcome during the early 1960s because behaviorism had become an impediment to useful theory construction. However, cognitivists became too liberal and unparsimonious in their theory construction as they ignored important aspects of biology, evolution, and animal psychology. Cognitive approaches may envision the brain to be like a computer, which, in Staddon's opinion, it is not. Psychologists should be concerned with

interactions among neural processes, biochemistry, and physical actions in response to an external world, not "mental" chemistry or physics, or "atomic" and "molecular" levels of mental processing (pp. 129–130). Staddon feels that while behaviorists initially were concerned with practical applications of psychology, their interests (especially Skinner's) became too utopian. Cognitivists, though, are concerned prematurely with mental processes and neural structures which to date are too complex to understand. After calling contemporary psychology "alchemy of the mind" (p. 179), Staddon calls for studying animals rather than the human "mind." In his words (p. 181), "the solution offered by theoretical behaviorism is simply to lower our sights. Don't reach for the stars; search for a telescope. Study the dynamics of simple animal behavior. Maybe the stars will arrive in due course."

Staddon's views may be controversial. Any suggestions for further understanding people by studying animals are far from universally welcome. Yet, the dominance of cognitive-organizational approaches to explaining human learning certainly is under challenge. Who is right? Ill understood though they may be, mental processes are involved in learning. Behavior may be observed and managed in laboratory settings; people are not rats or pigeons, but the diverse fauna do seek some common goals. Depending on one's beliefs and perspectives, *both* schools of thought are right. Perhaps a better question is "When is which right?"

Musical Development Across Age-Based Stages

Musical ability proceeds through a developmental sequence, running from basic sensory perceptions, some of which may be *in utero,* through complex abstract musical reasoning. The sequence is flexible, fluid, and subject to modification. To some extent, such a sequence is quite natural: Musical behavior is one form of human behavior, and most behaviors become more sophisticated and skilled in a developmental manner. A supportive and nurturing environment must interact with any natural aspects of musical behavior in order for someone to develop to the fullest extent musically. Normative information regarding what occurs when may be quite valuable in planning for music instruction. Much remains to be learned about the sequence, its individual steps, and the discrete nature of steps and developmental stages, but the literature suggests an overall pattern. In addition to the cited references, the following discussion generally is based on the research and descriptions of Dowling and Harwood (1986), Gardner (1993), and Hargreaves and Zimmerman (1992), as well as important articles in Deliége and Sloboda (1996). A capsulization of the information appears in Radocy (1994).

Musical development begins *in utero.* In addition to experiencing sounds of the internal maternal surroundings, such as heartbeat and fluid movements, the fetus can experience external auditory stimuli. As Lecaunet (1996, p. 24) indicates after a careful review of pertinent studies, musical sounds, as well as others, can stimulate the emerging fetal auditory system, which is functional about three to four months before birth. Changes in heart rate suggest consistent fetal startle reactions to external sounds during about the last two months *in utero,* and prenatal experience with particular stimuli may show in a postnatal preference for certain sounds, including a particular voice (often Mother), a particular tonal or speech sequence, and a particular language. Lecaunet concludes strongly that "prenatal experience as well as . . . any structurally organized sounds may contribute to shaping auditory abilities and to developing long-term preferences or general sensitivity to the type of sounds experienced" (p. 25).

Part of being a "normal" human is production of a species-specific sound (Kuhl, 1989, p. 379). The human's signal identifies its producer as "human." Infants engage in a "canonical babbling," i.e., a highly repetitive emission of consonant-vowel combinations, as in "ma-ma-ma" or "da-da-da." Such babbling occurs initially regardless of the language in the home, parental attributes, or, within wide limits, the infant's general motor and intellectual abilities.

As Papousek (1996, p. 44) indicates, the segmented repetitive canonical syllables are preceded by a prolonged cooing of melodic-like sounds, which soon develop into sounds with prolonged modulations and phrasing, which caregivers can support and reinforce. Canonical babbling leads to declarative use of vocal syllables and the acquisition of words. So, as part of their evolving prespeech sounds, babies may make individual tone-like sounds and produce short babbling patterns that suggest definite, albeit considerably variable, pitch.[16] The patterns vary in loudness and musical contour, thereby suggesting a certain amount of rudimentary musical expression.

Musical stimuli, which usually have relatively steady pitches and repetitive rhythms, stand out from other sounds. Infants may give attention to sources of musical sounds in their immediate environments and may respond with interest to a change in their aural surroundings, such as a different voice or instrument performing a previously heard melody. Babies as young as four months may notice changes in beat and tempo. Slightly older babies may respond to changes in contour, but transpositions to new keys are unlikely to arouse any interest.

[16]Brown's (2000) "musilanguage" theory of music's origin, noted in Chapter 2, proposes that humans originally communicated with a mixture of sounds which were neither music nor speech. The initial sound production of humans may microcosmically represent such a proposed evolutionary process.

Summarizing various studies, Trehub (1993) notes that infants are sensitive to contour but not individual pitch and interval changes. Interestingly, they occasionally can discriminate ascending from descending two-tone patterns, even though older children and some adults may have difficulty. Infants show a tendency to group rhythms, as in hearing XXXOOO (where X and O represent contrasting timbres or loudnesses) as two groups of three. Pauses between contrasting groups lack salience, but pauses within groups catch infants' attention. Trehub (2000) later notes that similarities in the perception of musical patterns between infants and musically experienced adults suggests a biological basis for aspects of musical processing, including focus on contour and rhythm rather than specific pitches and durations, remembering unequally sized scale steps better than steps of equal size, and placing musical details into conventional rhythmic arrangements. Pattern organization is not just happenstance.

Around two years of age, children begin to produce sound sequences that contain successive intervals which are found in their surrounding musical culture. *Spontaneous song,* an active creation of (to the children) musically logical sequences, commonly occurs during play and other periods of auditory expression. Most children gradually mix more and more imitations of songs they hear around them (*learned song*) into their creations; by approximately four years of age, learned song largely has replaced spontaneous song. Curiously, musicians may deem composition a skill which few possess or a skill which requires intensive and lengthy study. Yet, while many of their creations defy accurate notation, many children as a matter of natural development pass through a highly creative musical stage in which they do considerable "composing" within the scope of spontaneous song.

In addition to reflecting the surrounding musical culture through their songs, children learn cultural conventions and stereotypes by singing. In a study where children aged three through six years learned to discriminate between tonal and atonal songs, children as young as age three could discriminate *if* they were among the more competent singers, as demonstrated by singing "Happy Birthday" (Dowling, 1988). Simple songs evidently facilitate learning cultural scale patterns, even without formal training. Once the child learns the patterns, he or she continues to use them, even when the specific behaviors that led to acquisition of the patterns are forgotten.

Children from cultures employing languages in which pitch level has strong semantic importance may sing with somewhat different patterns than English-speaking children. In a small-sample study comparing singing of four-to-six-year-old Cantonese, Sotho (from South Africa), and English children, Chen-Hafteck (1999) found that the Cantonese and Sotho children sang more detached tones and were more skilled with larger musical intervals.

As with any developmental sequence, the musical development of babies and young children may vary considerably, and some babies may show remarkable skills. Ries's (1982) study of the spontaneous and learned song of 48 Canadian children remains illustrative. Employing naturalistic inquiry methods, Ries observed the children, ranging in age from seven to 32 months, in their homes, where they were able to perform before their parents and others with whom they were familiar. While extensive variation existed, Ries generally found that babies do sing in an expressive manner, with style, articulation, and vocal quality. Prelanguage babies are expressive vocally even without specific words. Her data suggested a developmental sequence of pitch or melody at seven months, articulation (separation of sounds rather than wailing) at eleven months, and very simple rhythms until nineteen months, when words were added. Children employed pulse and meter at thirty months. Learned song developed more slowly than spontaneous song. Ries found that 30-month-old children could sing spontaneous songs with definite tonality, although other research (Dowling & Harwood, 1986) suggests that tonality remains unstable until age five or six. These children were from a closely knit family-centered subculture, and Ries's results are atypical, but they do suggest that young children, ready in some cases for preschool, may be capable of rather advanced musical behaviors.

As children continue to mature and approach kindergarten (still the beginning of formal schooling for many children in the United States), their songs become longer. Tonal centers are more stable, even for those who previously fluctuated widely in their relationships to any home tone; rhythm patterns become steadier. Eventually, children, at widely varying rates, discover that certain musical properties may remain the same while others change. Intervalic structure and melodic contour remain the same even though the song changes in its tonal center. Tones and silences retain the same relative durations even though tempo may vary. Words seem to be especially relevant for children in learning a song; learning words or fragments of words (such as the "E-I-E-I-O" section of "Old MacDonald Had a Farm") may precede learning pitches.

Commenting on children's aural perception of musical events, Pick and Palmer (1993) note the sensitivity of five-year-old children to musical contour. Children can recognize transposed melodies and indicate that the same melody in different tonalities indeed is the same melody. They point out that young infants also are sensitive to contour, but with immersion in one's musical culture, sensitivity to contour and intervals within melodies increases.

The study of children's visual representations of musical sounds may be illuminating. In a study of five- through seven-year-old children, Davidson and Scripp (1988) found increasing sophistication in notation schemes with

advancing age, with pitch emerging as a primary basis for organization. The researchers found that the children employed five types of systems. In a *pictorial system*, the child simply portrayed a song title or events within the song through pictures or icons, as in drawing a boat for "Row, Row, Row, Your Boat." In an *abstract patterning system*, the child usually used lines or dots to represent relationships among melodic tones and phrases. Icons and words alternated flexibly in a *rebus system*. Children employing a *text system* wrote words with suggestions of ordered grouping, something like poetry. In a *combination/elaboration system*, the child used abstract symbols and words to represent simultaneously the song's words and musical dimensions–this system did not focus primarily on the words or use pictures or icons. Changing percentages in the relative use of each system across the three ages suggest increasing sophistication in notating songs:

Age	*% Pictorial*	*% Abs.Patt.*	*% Rebus*	*% Text*	*% Comb/elab*
5	26	43	8	18	5
6	8	41	13	23	15
7	3	28	5	36	28

Bamberger (1991) presents elaborate descriptions of children's pictorial representations of music. Children reflect their grouping of sonic events into various simple metric and phrase groupings, which become building blocks for more complex patterns.

In a study comparing four- to eight-year-old children's invented notations, Gromko (1994) found a relationship between measures of musical understanding and portrayed awareness of pitch and rhythmic relationships. Understanding, a variable based on factor analysis of the children's scores on Gordon's (1979) *Primary Measures of Music Audiation*, was more related to notational sophistication than to the children's ages.

As children mature until about age nine, musical ability tends to increase, largely as a matter of further cultural immersion. The sounds of the surrounding musical culture, including sounds from media as well as sounds produced in the home by children, parents, and siblings, build musical expectancies and a sense of what is appropriate musically and what is not. Children become increasingly familiar with predominant scales, intervals, harmonic conventions, and metric organization and subdivisions, as well as a specific repertoire of music. Even without formal instruction or any idea of correct labels for what they hear, the children build their musical expectancies and develop preferences. The authors strongly believe that this is a crucial time for developing intelligent and musically sophisticated future audiences and performers. Music educators and caregivers should exploit children's flexibility and openness to diverse musical styles during the preschool

and early elementary school years before they become locked into any one style. Overly narrow musical experiences lead to restrictive expectancies, which lead to restrictive preferences.

Further progress beyond the level of learning songs from the surrounding culture, creating similar songs, and being sensitive to differing musical styles, progress to what Hargreaves (1996, pp. 165–167) calls a "professional" phase of musical development, requires formal instruction, especially in music performance, but also in developing more sophisticated analytical and listening skills and the ability to read and employ conventional music notation. Cultures and individuals within cultures differ greatly in the importance they place on formal instruction; many Western cultures create a musically elite group of performers and composers and a large group of consumers. In the United States, relatively few people develop their musical abilities to a further level than that present around age nine.

People who do pursue formal musical study into adulthood may become skillful performers, some even reaching the level of expertise discussed in Chapter 7. Some individuals may become composers and arrangers. Others may become highly sophisticated listeners. A few may become widely adept in all fields of music. Of course, many music students will settle for less than "superstardom" or its equivalent, whether due to a lack of "talent," a lack of motivation, or stronger interests in fields of endeavor other than music.

Musical Abnormalities

"Normal" musical development is wide ranging, although much of it occurs in most humans who have anything approaching "normal" sensory and intellectual abilities (and even in some who do not). Yet, conditions exist that are well beyond even the wide range of "normal" human musical behaviors. Labelling phenomena as abnormal is a matter of judgment, and musicians, teachers, and others working with music should not be too quick to consider someone's musical behavior as abnormal simply because it is different. However, some individuals just can not or do not respond to music, and some respond in remarkably unusual ways. The authors have elected to discuss amusia, including its sub-condition monotonism, and synesthesia.

Literally, *amusia* means "without music." One medical dictionary (Spraycar, 1995, p. 66) defines amusia as "a form of aphasia characterized by an inability to produce or recognize music." The definition then exemplifies instances involving inability to play an instrument, produce rhythms, interpret or appreciate musical sounds, and sing. While amusia and aphasia (a speech production or comprehension impairment) may coexist, either condition may exist without the other, so classifying amusia as a subdivision is questionable. Levitin (1999, p. 217) indicates that most individuals afflicted

with amusia can understand speech, but have considerable difficulty in comprehending musical relationships, or in the performance, reading, and creation of music.

Amusia is a rather broad term; classifications include inabilities to detect basic tonal properties, difficulties in categorizing musical structures, and complex difficulties in melodic and rhythmic discrimination. Marin (1982) and Marin and Perry (1999) present detailed discussion and a hierarchical classification of amusias.

Amusia may occur following cerebral trauma; Marin and Perry (1999, p. 655) simply say that "brain damage" is the cause. Indeed, trauma is usually responsible, but there is emerging interest in a type of *congenital amusia,* which may be responsible for some cases of tone deafness. Ayotte, Peretz, and Hyde (2002) identified a group of 11 adults that fit stringent criteria for musical difficulties but who did not have any known neurological or psychiatric difficulty. The subjects showed no difficulty in processing speech, and, for the most part, had normal hearing acuity. They were well-educated and had had music lessons during childhood–with a history of musical failure. Yet, tests of scales, contour, interval, rhythm, and musical memory, originally designed for use with brain-damaged patients, showed considerable difficulty in music processing, especially regarding pitch discrimination. So, there may be a small segment of the population who have what the investigators call "an underdeveloped system for processing music" (p. 249). Music educators and therapists dare not assume congenital amusia whenever they encounter persons with pitch difficulties or other musical problems, but the condition exists.

Monotonism, where a person seems to sing only one tone, regardless of the musical situation, is an especially frustrating form of amusia. For many music teachers, it is an article of faith that there are no (or at least very few) true monotones. Orbach (1999, p. 262) suggests that no one is truly "tone deaf," in the sense that they can not distinguish pitch differences, unless they are unable to hear. Rather, the problem is difficulty in maintaining an accurate melodic sequence; monotones or "tone deaf" individuals may sing truly monotonically or with an out-of-tune albeit variant succession of pitches. Orbach prefers to call difficulty in "carrying" a melody *singing apraxia* (p. 262), and prefers to call amusia *dysphasia* (p. 372). Regardless of the cause, label, or incidence, one does find people with pitch matching problems and people who sing with a restricted range. Choral music teachers occasionally encounter a "droning" phenomenon among adolescent males, where the boys consistently sing below the designated pitch and usually produce only a few separate tones. Orbach suggests (pp. 262–263) that vocal difficulties are responsible for singing apraxia. Indeed, guided vocal practice may be beneficial for many monotones and near-monotones. Yet, there is the possibility

of congenital amusia.

Synesthesia perhaps is not an abnormality, at least not an impeding abnormality, although the phenomenon is hardly "normal." While any type of amusia clearly is a deficit, a person with true synesthesia has additional ways of experiencing the environment. Synesthesia is a multisensory response to a stimulus. In addition to hearing a tone, the respondent simultaneously experiences the tone in a nonauditory way, such as by seeing a color or smelling an aroma. The experience is one of conscious sensation, not merely verbal association.

In *chromesthesia* (the sound-color type of synesthesia), a consistent relation exists between color brightness and tonal pitch: Bright colors accompany high pitches; dark colors accompany low pitches. Unlike dual *spoken* vowel-color sensations, where red and yellow often accompany "ah"; white accompanies "ay" (as in "late"), "eh" (as in "let"), "ih" (as in "bit"), and "ei" (as in "beet"); red and black accompany "o" (as in "home"); and blue, brown, or black go with "oo" (as in "boot"), *tone-color* sensations are rather idiosyncratic (Marks, 1975). Haack and Radocy (1981) describe a case of an art teacher who experienced dramatic tone-color sensory linkages.

As with other unusual musical phenomena, the musician, music teacher, music therapist, or other person working with music should recognize that the person reporting the synesthetic experience quite likely is describing a real experience: The person is not ill.

Measurement and Prediction of Musical Ability and Learning

There are many ways to measure musical ability. A high level of musical achievement clearly indicates musical ability, at least of the sort necessary for achievement in the designated medium. Measurement of ability prior to successful pursuit of a career is more challenging.

Musical ability is defined operationally, rather than constitutively, by the particular means of measurement.[17] Some measures stress basic discrimination skills; others require more "musical" tasks. Some measures require musical achievement. Instrument manufacturers have published "tests" on which almost anyone who is marginally literate may score well.

This book is not a measurement text; only three widely known measures are discussed below. Readers who wish to investigate other tests and approaches to testing should consult Boyle and Radocy (1987) and scan *Dissertation Abstracts International,* as well as examine the historically important texts by Lehman (1968), Colwell (1970), and Whybrew (1971). Doctoral students occasionally engage in research directed toward test development,

[17]An operational definition specifies how a trait will be recognized in a specific instructional or research setting, while a constitutive definition is a dictionary-style definition.

and modern technology enables fairly sophisticated test design and administration. Boyle (1992) presents a detailed discussion of typical tasks which testmakers employ to assess musical ability.

Some Approaches

An experienced observer may assess musical ability by means of educated guessing. Children vary in the extent to which they actively seek to make and listen to musical sounds, "natural" though such activity may be. Children with older musically successful siblings may themselves be successful. Any child who asks for musical experiences certainly should be welcomed and encouraged, as should any adult. Unfortunately, educated guesses may mislead, particularly if they stress overt indicators. Discovering "latent" musical ability requires a more formal assessment. In order to illustrate diverse approaches, three representative approaches are discussed below. In all cases, the main concern is for the conception of musical ability the test represents.

The *Seashore Measures of Musical Talents* (Seashore, Lewis, & Saetveit, 1960) appeared initially in 1919 and were revised extensively in 1939. By 1994, the battery was out of print. The battery certainly had a pioneering status and long history of use, and it provided a reference against which to compare other approaches to assessing musical ability. Contemporary constructs and attitudes probably made the Seashore battery obsolete. Yet, the battery's exemplification of a belief that musical ability, especially in the aptitude aspect, rests in psychoacoustical discriminations retains importance.

The term "measures" rather than the singular reflected Seashore's view that musical ability consisted of loosely related specific sensory capacities. Each of the six particular measures was a measure of one narrow sensory skill; together, the measures yielded a profile that showed a pattern of auditory sensitivity. No total score was permissible, in accordance with Seashore's theory of specifics.

The Seashore pitch, loudness, time, and timbre tests required judgments of paired tones. The respondent respectively indicated whether the second tone was higher or lower, stronger or weaker, longer or shorter, and same or different in comparison with the first tone. Many of the differences were rather subtle, subtle enough that the fidelity of sound reproduction equipment and acoustical aspects of the testing environment could affect scores. Plomp and Steeneken (1973) demonstrated the variability of sound pressure level in reverberant sound fields and the place dependency of sound sensations for steady-state tones. Harrison and Thompson-Allen (2000) showed how organ sounds varied in SPL at different locations in an auditorium, and the resulting differences in loudness sensation were greater than the SPLs

would suggest. Furthermore, the contrasts varied with the organ timbre.

Seashore's rhythm test required indicating whether the second short monotonic rhythm pattern in a pair differed from the first; in the tonal memory test, the subject indicated which tone differed in the second version of a pair of short tonal patterns.

Seashore believed that auditory abilities had a psychological limit, so scores on his tests would not change appreciably over time, except as a function of misunderstood directions and experience in taking tests. Research long ago (Wyatt, 1945) showed convincingly that training procedures indeed could raise subjects' Seashore scores.

A person who equates musical ability with the Seashore tests' perceptual tasks or believes that such tasks are an important part of musical ability still may find the tests useful. They were fairly reliable and valid for what their creators claimed to measure. Someone who believes that musical ability must manifest itself in more than analysis of psychoacoustical differences and short-term retentions may prefer a more "musical" test; today's *zeitgeist* certainly favors more musical and less atomistic approaches than that of Seashore.

Wing (1954, 1961) believed that musical ability was largely innate, not necessarily related to intelligence, and uninfluenced by environment. He thought melodic, harmonic, and rhythmic discrimination skills were important, and believed in a pervasive general factor of musical ability. His *Standardised Tests of Musical Intelligence* require extensive analytical listening to piano tones and passages, and certainly are more "musical" than the Seashore battery. In the chord analysis and pitch sections, the respondent respectively must evaluate individual chords for the number of tones contained therein and indicate whether the second of paired chords contains a tone within it higher or lower than the first chord. The memory, rhythmic accent, harmony, intensity, and phrasing sections require comparisons of paired melodies, some of which are rather lengthy. In the memory section, the respondent must indicate which one of three to ten tones is altered in the second version. The other tests require the respondent to indicate if the second melody is the same or which one he or she prefers regarding the property in question. The Wing battery provides a total score.

The Seashore and Wing measures represent contrasting conceptions of musical aptitude–a psychoacoustical conception and a general musical factor conception. Another, more contemporary, approach is based in musical imagination, represented by Gordon's (1965a, 1988) *Musical Aptitude Profile*. The comprehensive battery includes three major sections and seven subsections; each section and subsection as well as the total battery yields a score. The respondent's basic task is to evaluate paired phrases; the stress is on what Gordon calls *imagery* or *sensitivity*.[18] The tonal imagery section contains

a melody subsection, in which the respondent must indicate whether the second phrase is an embellished melodic variation of the first ("same") or a different melody, and a harmony subsection, in which the respondent labels the second phrase as having a lower voice the same as, or different from, the lower voice of the first.

One subsection of rhythmic imagery requires the respondent to indicate whether the second phrase's tempo accelerates, retards, or stays the same. The second rhythm imagery subsection asks for a same-different comparison regarding metrical accents.

Gordon's musical sensitivity section contains three subsections. In each, the respondent must indicate which of two performances sounds better. In the phrasing subsection, musical expression varies. Endings differ, rhythmically and melodically, in the balance subsection. In a "style" subsection, tempo differences predominate.

The lengthy Gordon battery is thorough and includes an excellent manual. Initially developed after eight years of research, the battery purportedly minimizes musical achievement, as an aptitude measure should do (Gordon, 1965b). The person who conceives musical aptitude as sensitivity to tonal and rhythmic variation and nuance in a musical context may find the *Musical Aptitude Profile* useful in assessing aspects of musical ability through group testing.

The Seashore, Wing, and Gordon batteries are diverse approaches to measuring musical *aptitude*, intended to assess ability without requiring specific musical knowledge. In order for a person to use these or any other measures with belief in their utility, that person must be convinced of the measures' *validity*. In addition, he or she must believe that a one-time testing is valid.

Validity

Any test's validity refers to how well the test measures what it is supposed to measure. One must not confuse validity with *reliability*, the consistency with which a test measures whatever it is measuring.[10] While a test must be reliable in order to be valid, a test may be quite reliable and yet be invalid, as in using a highly reliable final examination for a music history class as a measure of musical aptitude with kindergarten children. (While such a ridiculous use is highly unlikely, instances of invalid testing do occur, as in expecting one to read formal music notation as part of an aptitude measure.)

Test constructors estimate reliability by correlating two forms of the same test, correlating two administrations of the same form, or correlating scores on two halves of the test. In addition, internal consistency techniques may estimate the average interitem correlation. An authoritative discussion of classical reliability techniques appears in Stanley (1971). Reliability estimates theoretically may range from -1.00 to +1.00; negative estimations are rare. The closer to +1.00, the more reliable the test.

Given sufficient reliability, a number which usually should be .80 or higher (in the authors' opinion), a test needs a sufficient rationale for *why* it is a test of whatever it is supposed to test in order to be valid. Since musical ability is not defined clearly, no predictive measure of ability is completely valid, and the validity of any given test will vary with the test user's beliefs and actions.

If a purported measure of musical ability is valid as a predictor of musical success, a logical way to validate such a test is to administer it to a large representative sample, measure the sample's musical success later, and look for a strong positive relationship between scores and success. This often is called criterion-related or predictive validity, and a problem may exist with the criterion's validity. Musical success often means achievement in a formal instructional setting. Children particularly may be "unsuccessful" because of organizational and personality problems rather than musical problems. Teacher ratings easily are influenced by nonmusical variables. Correlating a new with an old test presumes that the old one was sufficiently valid.

Validity may be a matter of how well the test represents a designated body of material. This is content validity and is more readily appropriate for achievement than for aptitude measures. It requires a fairly complete specification of just what a musically able person should be able to do.

Construct validity, the extent to which a test measures ability in accordance with underlying theoretical constructs of ability, is difficult to establish. Invalidity may be a failure of the test or a failure of the theory.

Whatever the test's claims for validity, the prospective test user personally must decide whether the test appears valid. Someone who believes that musical ability truly is largely a matter of fine sensory discriminations of isolated tonal stimuli might be comfortable in using the Seashore battery or another test with similar characteristics. Someone who believes that "sensitivity" to underlying structures is important might endorse the Gordon *Musical Aptitude Profile*. Someone who believes that no one-time testing can possibly assess the likelihood of future accomplishment adequately may believe that no conventional test is appropriate.

[9] In other work, Gordon developed a series of tests of *audiation*, i.e., recalling or creating musical sound without its physical presence. Presumably, audiation requires evaluating an immediate series of auditory impressions. The difference between "imagery" and "audiation" may be somewhat pedantic; for a discussion of some of Gordon's audiation measures, see Boyle and Radocy (1987, pp. 151–153).

[10] A more technical definition is that reliability is the proportion of overall variability in the test scores that is due to genuine differences in the measured property.

Importance of Nonmusical Variables

Given the facts that musically able people may be able in other areas and that evaluators of musical success may employ nonmusical criteria, it is reasonable to examine the idea that additional nonmusical variables might increase the accuracy with which one might predict musical success. Two classic studies employing multiple regression analysis, a technique for relating a series of predictor variables to a criterion variable, illustrate utility for nonmusical or extramusical predictors of musical success.

Using students from a university laboratory school, Rainbow (1965) found that interest in music and socioeconomic background, along with pitch discrimination and tonal memory, were significant predictors of teacher ratings' of elementary students' musical abilities. For junior high school students, the significant predictors were academic intelligence, gender,[20] and relatives' participation in music, along with prior musical achievement. Teacher ratings for high school students were significantly predicted by home enrichment and interest in music, as well as pitch discrimination and tonal memory. For all school levels taken together, academic intelligence, home enrichment, interest in music, and socioeconomic background, as well as tonal memory and musical achievement were the significant predictors.

Hedden (1982) studied the effectiveness of attitude toward music, self-concept in music, musical background, academic achievement, and gender as predictors of the musical achievement of fifth- and sixth-grade students in two schools. His most significant predictor, accounting for 25 percent of the variance in musical achievement in one school and 40 percent in the other, was academic achievement. Addition of the self-concept measure in one school and the attitude measure in the other increased the respective amounts of "accounted for" variance to 34 and 61 percent. The other variables, including musical background, were not effective predictors. (While Rainbow used music teacher ratings as a criterion variable, Hedden used a formal test, the *Music Achievement Tests* (Colwell, 1969).)

What Should We Measure?

While formal measures of musical and nonmusical variables may aid in measuring and predicting musical ability, no one test is likely to be adequate by itself. A reliable and valid battery that tests musical skills which the investigator deems important in combination with tests of intellectual ability, academic achievement, prior opportunities for musical stimulation, and, where necessary, physical attributes probably offers the best approach to making judgments of musical ability on which to make decisions regarding student recruitment, selection, and counseling. With increasing understanding of sequential musical development, Sloboda's (1985) belief that "musical expertise" consists of awareness of musical structures, such as melodies, harmonies, rhythms, and underlying "deep" structures, has increasing utility: Assessing where a person is in some sequential development of musical awareness and sensitivity may be beneficial for assessing musical ability.

[20]Yes, we said that musical ability does not depend on gender. Rainbow's significant gender-chievement relationship is a *relationship*–not a cause and effect. In 1965, junior high boys tended be less enthusiastic about musical achievement than girls, and the teacher ratings may have been fluenced by obnoxious student behaviors!

There is no substitute for providing an *opportunity* for success, of course. Shuter-Dyson (1999, p. 645) stresses the importance of a social climate in which people value and enjoy music, and the chance to do something usually is the best predictor of whether a person is able to do something. Conceivably, one could assess the zone of proximal development, mentioned earlier, via a series of ordered musical tasks: Perhaps more musically able persons have wider zones of proximal development; i.e., they are more able to profit from musical instruction.

Philosophically, one can question the selection and development of a musical elite. While such an elite may be "natural" in a competitive society, particularly when resources are limited, some of the world's peoples do not recognize a musical elite. Blacking (1973) discusses at length the Venda people of South Africa, for whom musicmaking is more of a social than a technical experience. The Venda recognize that some individuals may be better performers than others, but the possibility of *anyone* being unmusical is alien to their culture.

Allowing an "unmusical" person to try to learn to play an instrument or develop sophisticated listening skills is far less risky than allowing a person who wishes to be a pilot but seems potentially to have little airplane flying ability to enter flight school. Pursuit of a musical career by a person lacking successful musical achievements is dubious, but a child who has had no musical training should not be denied musical opportunity. We know enough about musical ability and normal musical learning to know that these are complex areas, with many facets. We do not know enough about musical ability and learning to use them as barriers. And music educators should not be desirous of establishing musical barriers.

Practical Suggestions Regarding Music Education

A student brings his or her experiences, strengths, and weaknesses to the music learning situation. As the reader easily may surmise, instruction and learning involve numerous aspects, and no one theoretical explanation is completely adequate. While the authors respect important aspects of many

theories (e.g., children's brain processes are organized differently than adult brain processes, behaviors may be altered through reinforcement contingencies, appropriate stimulus organization facilitates learning), they are not "true believers" in any one theory. Nevertheless, a large amount of literature as well as personal experience suggests particular principles for guiding instructional planning and evaluation. While no recipe for successful teaching exists, useful suggestions for applying some of what we know about musical learning and development flow from theoretical work and research. The following ideas, based on and expanded and revised from Radocy (1982) and Boyle and Radocy (1987), are presented from the teacher's standpoint.

Clear specification of what students are to learn and how the teacher will evaluate their learning provides content, context, and structure. For musical performance, specification of what to learn includes descriptions of intermediate steps, which involve structured practice. General instructions to "practice" are less useful than specification of what and how to practice. In particular, students need to practice in musically meaningful segments–phrases rather than measures, musical sections rather than printed lines. While it may be necessary to practice troublesome spots, even individual tones, in isolation and at varied tempi, the student should incorporate those isolated spots, at appropriate tempi, into the musical flow as soon as practical.

Evaluation should be in accordance with finding information to enhance students' musical experiences. The information should improve performance, expand knowledge, and facilitate revising curricula and instruction. Evaluation should not be a scare tactic. ("We have *ways* to make you practice!")

In instruction and evaluation, a teacher must avoid excessive abstraction with younger students. One need not be a Piagetian "true believer" to recognize that young children often require specific concrete examples of musical situations. Duple and triple meter, ascending and descending lines, simple binary and ternary forms, and other basic musical organizations are abstract, largely meaningless labels unless they are attached to meaningful aural examples. For students of any age, the provision of models and examples is beneficial. It is especially important for young children to have opportunities to *experience,* through movement, singing, or instrument playing, musical activities that exemplify the musical concepts we desire them to develop.

While music educators may argue about the relative importance of music reading, much musical learning is and will continue to be based on what is represented in musical notation. Technological developments, especially in the ability to print clear high quality notation from a computer, may have made notation problems in unpublished music less likely. Yet, one must strive for as clear and neat notation as possible. Excessively small notation, carelessly written manuscript, and notation that violates the principle of rhythmic spacing invite needless difficulty in reading. While there may be traditions to uphold, and, in vocal music, alignment of words with notes may be a consideration, the vocal style of separate flags for each note is more difficult to organize in relation to beats than the instrumental style of grouping notes via beams.

While people may disagree about the theoretical role of reward and reinforcement, and people will vary greatly in what is rewarding and how often reward must occur, everyone needs some form of reward at some time. Accordingly, a learner's demonstrations of desired behaviors merit praise; tangible rewards should accompany music learning. Saying such things as "good job," awarding stripes and medals for band uniforms, and other tokens of appreciation may be of considerable value in maintaining interest and motivation. One must be careful to adjust reward and reinforcement to take the student's level and actual accomplishments into account. To praise a fifth-grade beginning band student for correctly assembling an instrument is fine; to praise an experienced performer for assembly is absurd. Public praise in front of a student's peers, especially in middle school or early high school, may be more embarrassing than rewarding. In all circumstances, there must be something praiseworthy; to say "good job" when a student knows it was anything but good is counterproductive.

Motivation is critical. Modern students usually are able to hear high quality recorded performances in various musical styles, but they may lack the patience to spend the time and effort to make their performance sound like their auditory images. This requires motivation, not only toward long-term goals, but also toward short-term goals necessary for musical progress along the way. Maintaining motivation requires the teacher to provide opportunity for rewards, intrinsic as well as extrinsic, and to make the experience of learning music basically positive.

Teachers should treat failure to learn as failure to *learn,* not failure as a person. Errors require correction, not guilt. While teachers must address undesirable, counterproductive, or "off task" behavior, when possible, chastisement should occur in private. One interesting aspect of human interaction is the way in which many people find it easier to provide negative rather than positive criticism. An ensemble director may chastise one student who is late for rehearsal without praising anyone who arrived on time. A critique of a performance may stress wrong notes and other flaws with little mention of positive aspects. While error-free learning may be impossible, and error recognition and correction are essential, recognition of a performance's positive aspects may help sustain a student's desire to correct errors and improve.

Especially for younger students, frequent spaced instruction is superior to

less frequent concentrated instruction. Meeting twice a week for thirty minutes each allows more opportunity for reward and error correction and less time for practicing mistakes than meeting once a week for 60 minutes.

Musical activity should not be used as a threat or punishment. Parents should not discipline children for sundry offenses by forcing extra practice, and teachers should not call extra rehearsals out of anger rather than for attaining musical goals. Also, the possible use of negative reinforcement[21] in releasing students early from practice is questionable: Should teachers "reward" students for musical accomplishment by reducing the students' experience with music?

One need not believe that the theoretical importance of practice is to protect prior learning in order to realize benefits of practicing for specific performances under a variety of conditions. Seemingly trivial things such as the location of music stands or seating position on stage can distract relatively novice performers unless they have learned to adapt and adjust. Acoustical conditions vary among performance sites; touring ensembles may find it advantageous to simulate varied amounts of reflection.

Lastly, making music is more than *re*creation; it is a creative process. One needs to tolerate experimentation and new ideas, and yet insist on disciplined expression of results.

Summary

This chapter's key summative points include the following:

1. *Ability* is a broad term, denoting having the necessary skills and experience to do something; it is broader than *aptitude,* which denotes ability minus the results of formal instruction, and *capacity,* which denotes genetic endowment.
2. *Development* is a process of growth and maturation, which is partly dependent on learning.
3. *Learning* is a change in observable behavior that is not attributable to anything else.
4. Musical ability does not depend on superior auditory acuity.
5. The influence of genetic endowment on musical ability is uncertain; much evidence of familial musical accomplishment is intertwined with environmental factors.
6. While not everyone can learn everything, a nurturing environment is crucial for developing musical ability.
7. Physical features are unimportant in musical ability, except to the extent that particular performance media may be involved.

[21]Negative reinforcement is the removal of something the learner finds aversive. It is not punishment.

8. While some musical behavior is creative, creativity is too ill-defined as a construct to be a valuable predictor of musical ability.
9. Intelligence may be related to musical ability; that relationship may be a function of how one conceptualizes and measures the properties.
10. A musical intelligence may be part of a set of multiple intelligences; evidence includes musical prodigies and *idiots savant,* a particular developmental sequence, and a core set of musical operations.
11. Neither gender nor ethnicity are valid predictors of musical ability.
12. Musical ability probably results from an interaction of audition, physical coordination, intelligence, and experience.
13. Theories of learning include *behavioral-associationist* and *cognitive-organizational* theories; the latter have been more dominant in recent years, although a "new" behaviorism may be emerging.
14. The theories of *Thorndike* (stimulus-response connections resulting from consequences), *Pavlov* (becoming conditioned to some signal that elicits a response), *Guthrie* (a movement becoming associated at full strength with a stimulus), and *Skinner* (emitted responses shaped to desired behavior through judicious use of reinforcement) exemplify behavioral-associationist theories.
15. The theories of the *Gestalt* psychologists (learning is a matter of perceptual organization) and *Piaget* (learning is a developmental unfolding through several stages of maturation), and a view of learning as a perceiving-acting cycle (detection of and acting upon information) exemplify cognitive-organizational theories.
16. *Piaget's* stages are useful in showing that children fundamentally differ from adults mentally, but the stages are not as rigid as once thought and may be more appropriate in areas other than music.
17. *Vygotsky's zone of proximal development,* the difference between what a person can do and what he or she might do if given instruction, may be useful in assessing musical ability and learning.
18. A perceiving-acting cycle, advocated by *Young, Barab,* and *Garrett,* proposes that an individual detects information in accordance with particular limitations and acts on the information to transform the environment effectively.
19. Musical development proceeds through a sequence from *in utero* into adulthood, partly due to innate developments but also due to musical experience.
20. Infants naturally make sounds and notice their auditory environments.
21. Young children proceed through a stage of *spontaneous song,* which usually is replaced by *learned song.*
22. Young children generally are more sensitive to melodic contour than to intervalic detail within a melody.

23. Words seem to be especially important to children in learning songs.
24. Children's created notations show increasing sophistication, not only with advancing age, but also with advancing musical understanding.
25. Although musical learning and achievement occur at all ages, a child's preschool and early elementary school years are very important for developing musical expectancies and preferences.
26. While much musical learning and development seem to occur as a result of immersion in a musical environment, progress beyond that of the early elementary school years usually requires formal instruction.
27. *Amusia* refers to inability to perceive or produce music; it usually results from brain trauma but may be congenital.
28. *Synesthesia* is a multisensory response to a single stimulus; a common form is experiencing a color as a visual sensation along with hearing a tone (*chromesthesia*).
29. Tests by *Seashore, Wing,* and *Gordon* represent diverse traditional measures of musical aptitude.
30. *Validity,* the extent to which a test measures what it is supposed to measure, is a major concern; using any test to assess any form of musical ability implies agreement with the testmaker's concept of valid indicators of ability.
31. Especially in formal instructional settings, nonmusical or extramusical variables such as academic achievement may be useful predictors of musical ability and achievement.
32. A variety of indicators should constitute measures of musical ability.
33. There is no substitute for providing *opportunity* to learn music.
34. One need not be a "true believer" in any theory of learning or evaluation in order to make practical applications of theories to instruction and evaluation.

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Chapter 11

FUTURE RESEARCH DIRECTIONS

What does the future hold for research in the psychology of music? The quick cavalier answer is "Who knows?" A few cynics might even say "Who cares?" Yet, some speculation is worthwhile and potentially interesting, especially when viewed later with a certain degree of hindsight. The complex corpus of human behavior occurring in musical contexts retains its fascination, and all of society's waxing and waning concerns impinge on musical creation, recreation, performance, analysis, and appreciation.

In the first (1979) edition of this text, the authors suggested that the study of hemispheric specialization and synesthesia would have a major focus. There was considerable interest in "left brain-right brain" comparisons and the "musical brain" at the time, due in part to various attempts at reforming education. Indeed, considerable future research occurred, but, two decades after the authors' suggestion that hemispheric specialization was a major research area in music psychology, Basso (1999, pp. 411–412) concluded that hemispheric specialization research results were "ambiguous" and that results can differ with the musical task. Evidently, the first edition's related conclusion remains: The human brain is a complex organ, in contact with all of its sections. Musical behavior may be a product of either hemisphere, of both acting together, or of neither. Cerebral specialization for music depends on the nature of the musical task and the experience of the performer or listener.

Synesthesia remains an interesting phenomenon, but it appears more of a curiosity then a concern for most individuals interested in music psychology. However, it occasionally attracts attention in the press, and modern brain imaging techniques may enable neuroscientists to gain increased understanding of synesthesia (Begley, 2002).

The authors' second edition (1988) predictions proved somewhat more accurate. Multiple intelligence, especially as exemplified by Howard Gardner's (1993) work, indeed spawned considerable interest, as did the study of musical expertise (e.g., works appearing in Sloboda (1988)). Those ideas remain important, although some skepticism regarding multiple intelligences exists (e.g., Shaw, 2000, p. 12), and, as Chapter 10 indicates, Gardner has revised some of his ideas slightly.

For the third edition (1997), the authors expressed caution regarding potential fads and oversimplifications and warned about making extravagant claims for music, especially as a healing agent and as an enhancer of intelligence. For this fourth edition, the authors feel compelled to express similar concerns; people are prone to "rising above the facts" and making much of a small amount of information.

Although the reaction of some persons, anxious to "justify" music education or exploit parental concerns for enhancing intelligence, to the "Mozart effect" may exemplify "rising above the facts," the authors will not belabor the "Mozart effect" again; that topic is discussed thoroughly in Chapter 3. Suffice it to say that the effect, to the extent it exists, is highly specialized and topical. While there are sound theoretical and empirical reasons for optimally complex music to enhance pattern recognition and development (Shaw, 2000, pp. 7–8), one can not enhance intelligence *en masse* by exposing young minds to Mozart.

Some psychologists, educators, and interested laypersons give much attention to the brain, and to the importance of early exposure to musical stimuli. This certainly is appropriate; as earlier chapters report, learning must involve the brain, and young children usually are open to a wide variety of musical sounds. Yet, one must be careful not to adopt a "now or never" attitude that assumes that musical development requires extra stimulation during life's first three years. Bruer (1999), discussed in Chapter 10, notes that it is premature to link "brain science" to education, and that people tend to employ a minimal understanding of neuroscience to advocate policy decisions.

Perhaps considerable emphasis *will* occur in the area of neuroscience and music. Whether labelled as neuromusicology, neuropsychology, or otherwise, applying neuroscience to the study of musical phenomena has considerable promise. Certainly, there should be increased efforts to understand just what occurs during the processing and recall of musical stimuli, especially given rapidly expanding technologies that enable monitoring of ongoing neural functions. The authors have discussed in previous chapters such things as information theory, fundamental tracking, hierarchical perceptual structuring, abstract performance plans, and loudness summation, all of which obviously invoke neural processing. A deeper and more detailed understanding of the brain and the neural networks would make associated knowledge much more complete and useful. Possibly it would temper unwarranted naive enthusiasm for educational fads based on incomplete understanding of tentative or tenuous research, such as the oft-cited Mozart effect and the earlier "music in the right hemisphere" fad.

As Leman (1999) indicates, neuromusicology is relevant to research into the understanding of musical behavior. He stresses that neural principles may be useful in explaining musical achievements. This will require study-

ing neural processing in "natural" contexts and connections across disciplines, such as musicology, computer modeling, experimental psychology, and music theory. Also, one must consider that music learning and cognition occur within particular cultures; culture may even override sensation, as in the acceptance of dissonant sounds within some cultural contexts but not others. Both *sensory neuromusicology,* study of musical stimulus processing from the cochlea to the auditory cortex, and *cognitive neuromusicology,* study of the cortical aspects of music cognition, will be important in any ultimate explanation of musical phenomena and behavior. While the study of topographical neural representations and their relations to musical knowledge is important, there is far more to neuromusicology than any localization of musical phenomena.

In Chapter 2's discussion of music's origins, the authors noted the possibility of a common origin of music and language, in which both speech and music arose from a "musilanguage" that was neither speech nor music, early in evolutionary history. Similarities between music and language also are relevant regarding hierarchical perceptual structuring, where "surface" features, akin to what musical notation indicates, are subsumed into deeper and more abstract underlying cognitive processes and structures. Neuroscientific study of linguistic and music processing suggests that similarities in brain activity vary with the aspect of language or music. Semantic processing (meaning) is rather different, but there are strong similarities between musical harmonic processing and linguistic syntactical processing (word order), as well as between temporal aspects. Put another way, neural processing of language and music is more similar in structure than in meaning (Besson, 1999).

Basso (1999) suggests that "neuropsychology of music" can address the question of whether musical ability grows from general cognitive functions or has a specific "modularity," independent of other cognitive functions. This relates to the concept of musical intelligence as part of a group of intelligences, but it also addresses how cultural aspects shape musical behavior. The authors have mentioned the possibility of "musical universals" in earlier chapters; they also have given considerable emphasis to music being a sociocultural phenomenon. Music as ordered sound and silence is basic to humanity; the form that ordering takes is rooted in culture. In Basso's words (1999, p. 409),

> the universal aspects of music are directly linked to the brain, as language is directly linked to some brain areas; the relationship between the brain and the culturally determined aspects of music is not direct, and passes through the relationship between the brain and the cognitive functions underlying these aspects of music.

To conclude, the authors make two predictions: (a) The next few years will see more investigation into neurological processes related to musical behavior; and (b) people, particularly some music educators and entrepreneurs, will overreact to various findings with limited understanding. We also safely can make a third prediction: Regardless of what anyone says about music and what it is or is not, can do or can not, music will remain a basic part of humanity.

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AUTHOR INDEX

Citations to jointly authored works are listed by the first author only. For example, the Getzels and Jackson study is listed here only as Getzels.

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